AMERICAN MACHINIST

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ENTERED AT POST OFFICE, NEW YORK, AS SECOND CLASS MATTER.

The Parish Improved High Speed Engine.

We present, with this, engravings of a high speed engine built by the Ottawa Iron Works, at Ferrysburg, Mich. The intention in the design of this engine is to provide for high piston speed, that is up to 900 feet, and at the same time to bring this about by a construction that shall insure reliable operation, and require no especial skill or attention.

To provide for this the frame which is of the girder type, is strongly proportioned, and the center line of the cylinder is brought as near the foundation as practicable, by which means the vibration incident to rapid reciprocation is reduced.

The main journals are large, well fitted, and provided with boxes which are adjusted at an angle between the horizontal and vertical planes, the intention being to provide for the required adjustment in each direction, without the use of side gibs, or loose parts.

The connecting rod, which is three times the stroke of the piston in length, is fitted with solid ends, the adjustment of the brasses being made by the means of wedges and screws. This ample length reduces the friction, and the absence of loose parts has been found advisable in high speed engines.

The crank pin is of steel, and is accurately ground and fitted to a counter-balanced disc crank.

The cross-head is arranged with a removable pin, so located as to bring the bearing for the connecting rod in the center, while the gibs, which are of large surface, are adjusted for wear in such a way as to be at all times substantially backed to prevent springing and distortion, and to bring about equal wear of slides and gibs. The advantage of the removable pin is in the fact that it can be removed for repairs, or a new one substituted at any time at a trifling expense.

To provide against loss from clearance, and to bring about the compression necessary for smooth running at high speed, without distorted valve motion, the ports are made as direct as practicable from each end of the cylinder.

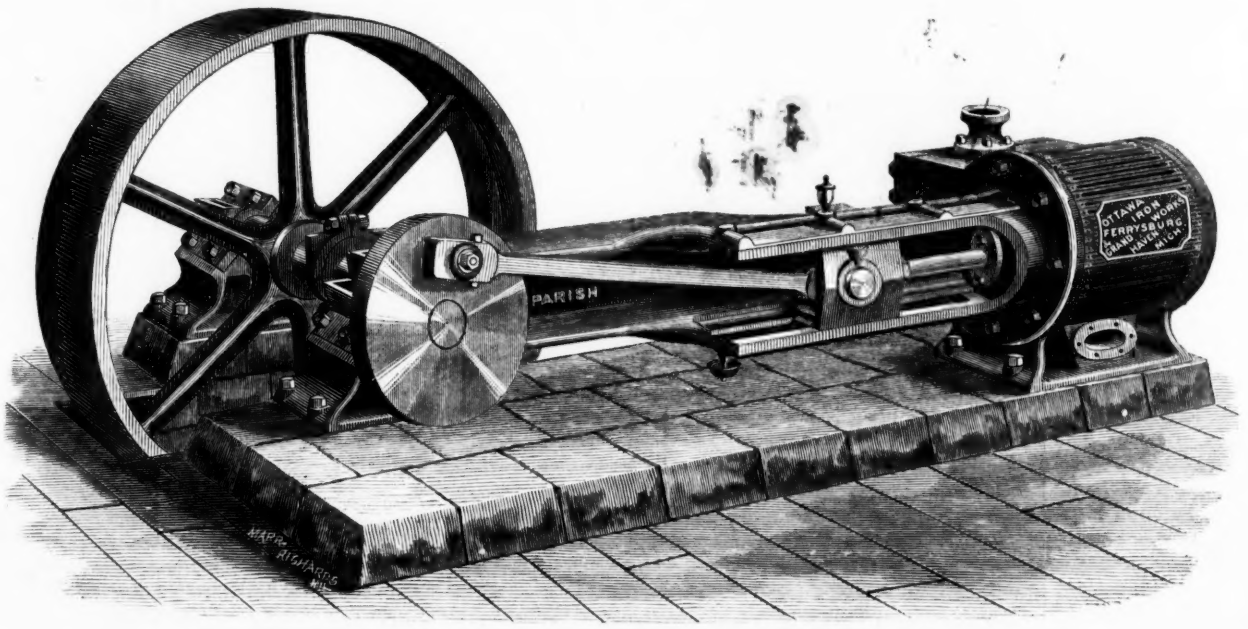
These engines are made with automatic cut-off, adjustable in the usual manner by the governor, or with plain slide valves and throttling governor, as may be desired.

The automatic cut-off is of course designed for use where fuel economy is an important consideration, while the plain slide valve with throttling governor is more particularly adapted to situations where fuel is of little value, or, as in some instances, in saw mills and wood working establishments, where it is sometimes rather an advantage than otherwise to dispose of the waste which is used for fuel.

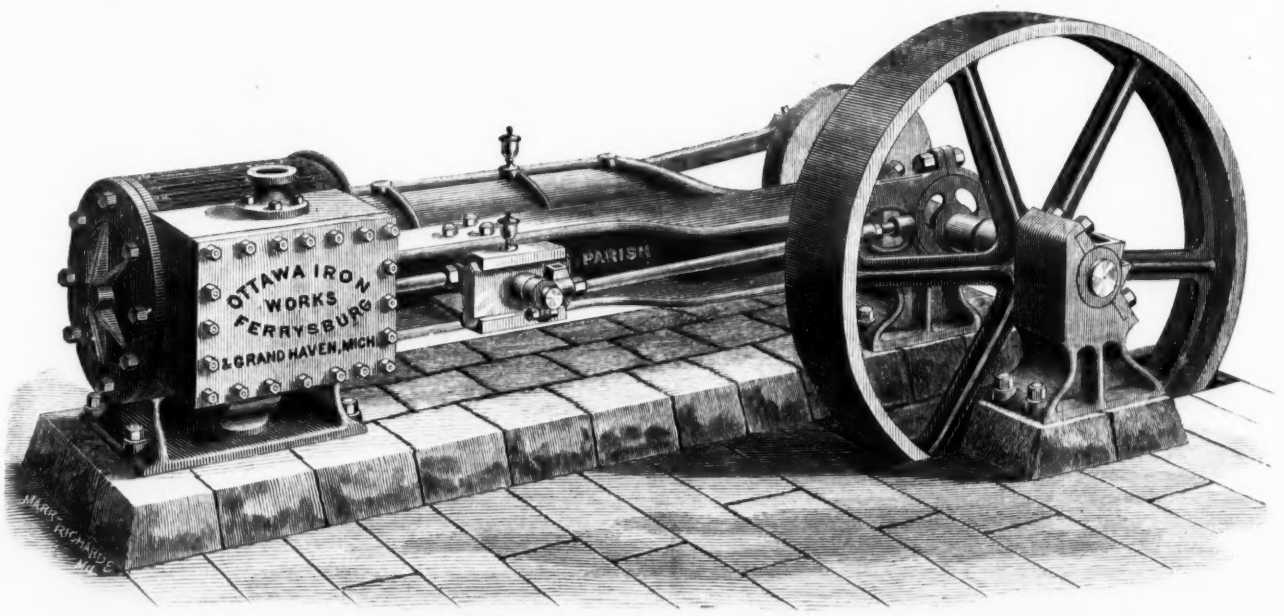
The speed at which these engines may be run makes it convenient to connect direct, and when connecting by belt permits the use of pulleys of nearer equal diameters, and hence better belt action.

The arrangement of cut-off for automatic operation consists of supplementary valves in connection with a ported slide.

The valve rod, piston rod and other parts, where advisable, are made of steel, and throughout convenient means of adjustment, and for lubrication are provided.



FRONT VIEW OF THE PARISH HIGH SPEED ENGINE.



BACK VIEW OF THE PARISH HIGH SPEED ENGINE.

Contraction and Cracking of Castings.

BY THOMAS D. WEST.

The query of why a casting cracks, is generally looked upon as a conundrum; at least the different answers to the question, and the different theories on the subject, would lead one to think so. There are very few things about a foundry that seem to be so little understood as the contraction of iron when cooling. Few appear to know whether there is any difference in the contraction of thin and thick castings, hard or soft, or hot or dull iron. Is the contraction of iron gradual, or is it true that castings have little or no contraction vertically as is thought to be the case by a writer on "Why don't castings shrink vertically?" in the AMERICAN MACHINIST, March 26, 1881, and signed "Moulder."

The writer of the article referred to will please excuse me for not noticing it before. My only excuse is that I was waiting to see if some one else would not answer it.

My opinion is that castings do shrink vertically, which opinion is borne out by experience, and by practical tests which I have made.

Not long since I had two patterns made, 54" long, by one inch square. These patterns were moulded in two flasks. One flask was suspended so as to cast the mould vertically, and the other was cast horizontally. When moulding the one that was to be cast vertically, care was taken to ram it so that there would be no straining on the sides, and to prevent the lower end from straining, there was an iron chill rammed firmly up against the end of the pattern. These two flasks were cast out of the same small ladle of iron. If "Moulder" will try his theory by the above practical test, he will see where it is not correct, for he will not be able to tell, so far as the contraction is concerned, which of the castings were cast vertically. This is as fair a test as could be made to determine whether castings contract vertically or not. The moulder may say he has measured castings that have been cast vertically, and found no contraction. This may be all true enough. There are lots of castings thus made which will measure longer than the pattern. So also many castings cast horizontally have been found to be larger than the pattern. Again the question could be asked "What is the cause of this?" to answer which it can be said: the straining of moulds.

A moulder or pattern maker that has had experience in making heavy rolls will, or should, always make the lower end of a swept mould, or the pattern, smaller than the end that is cast up. How much smaller will depend on the length and body of the casting. The difference will vary from 1-16 up to ¼ of an inch.

I have seen a rolling mill boss come into a foundry with such fire in his eyes that the poor moulder has trembled all over, when asked, "Why, in the name of common sense, he could not make the lower end of his rolls the same size as the upper end," and not have the wabbler so much too large, that it would

take a good chipper a week to chip it so as to have the coupling that goes easy on the top end fit the bottom end.

That castings contract vertically has often been proved in making rolls I have seen the upper wabblers cracked and pulled off from the neck of rolls, from no other cause than the contraction of the casting, and the carelessness of the moulder. That is, when feeding up his roll with hot iron to supply the shrinkage, he would let a flange form on top of his feeding head, so as to come out and rest on the iron flask or boxes that are used for forming the feeding head, and when the cooling crust commenced to contract it was held up by this flange. Of course it formed a crack or breakage in the neck, or wabblers, because the half molten metal was not strong enough to lift up the whole roll from the bottom of the mould.

In moulding castings that are cast vertically, there is generally more or less straining of the bottom portion of the mould, which in many cases cannot be avoided. Loam and dry sand moulds are strained more or less, but of course not so much as green sand moulds. To know whether a casting has contracted vertically or not, it is necessary to take exact measurements of the mould (not the pattern or sweep), as there is often a difference between the mould and the sweep or pattern.

After the casting comes out, compare the measuring rod or stick with it, carefully note and allow for evident straining. I think it will be found that the casting has contracted as much vertically as it would horizontally, were it possible to have cast it so. There are often castings poured horizontally that if measured would not only show no contraction, but would be larger than the pattern they were moulded from; especially if the castings were heavy.

Cores will sometimes greatly prevent the free contraction of a casting. Often light proportioned castings, having cores surrounded with metal, will crack, from there not being body enough of iron to press the cores together. When iron is run all around cores, and the thickness of iron is over one inch, the cores will expand so as to force iron up through the feeding heads, risers and pouring gates. Should the tops of the gates get frozen soon after the mould is poured, so as not to allow the expanded iron to come out through the gates, the iron will press against the sides and surfaces of the mould, forcing them outward, and when the castings come out, they are sometimes found to be larger, or as large, as the pattern; thus showing as far as measurement is concerned that there has been no contraction.

The purer or better the grades of irons, the less contraction there is. Heavy bodies of iron contract less than light ones. The more contraction there is the more liable are the castings to crack. Castings having light and heavy parts combined or connected, always have a strain on them.

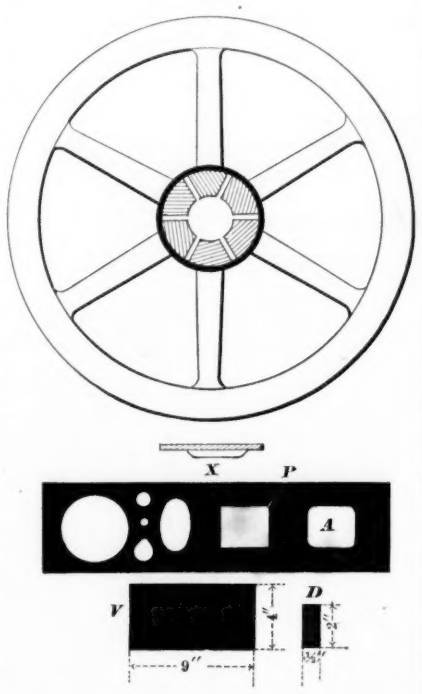
Pattern makers usually allow the same shrinkage on all castings. If they would make a small piece the same size as some part of a mould to be poured, and have a piece moulded and poured from the same iron and at the same time the main casting is poured, they would find that generally the iron contracts differently in the two cases.

The moulder when drawing these test pieces must be very careful not to rap them end-ways.

It is not the pattern makers that are to blame for the prevailing ignorance of the different contraction of iron in light and heavy castings. It is the foremen and proprietors of the foundry, for allowing the pattern maker to use the same shrink rule for every pattern he makes.

When a casting comes out too large, the first thing that is thought of is to swear that the pattern maker has made the pattern too large. When it is measured and found to be right, they come to the conclusion that the moulder has let his mould strain too much, which is an admirable corner to crawl out of.

If proprietors of foundries would order their foremen, also their pattern makers, to take measurements for one month of all the different forms of castings that they may be called upon to cast, at least all that are large and of different proportions; also, during this month's experiments, make test bars of all the different grades of iron that are used in the foundry, and after making note of their contraction, then try their tensile or breaking strain, something would be learned. To do all this requires no great labor or time. Moulders that take an interest in their trade could, whenever they make a casting of any note, test the contraction and keep a record of experiments that would be valuable.



The moulder or pattern maker is not always responsible for the breaking or cracking of casting. The designer or draughtsman often designs forms that the best of iron and management would not prevent from cracking. Sometimes castings will stand in the shop for weeks and even months, and to the surprise of all will then crack.

Not long since I had occasion to cast a bar 4″ × 9″, and 14 feet long. With the same quality of iron I cast a test bar exactly the same length, and 1½″×2″, both of which are shown at *V* and *D*. The contraction of the thick bar was only ¼″, while that of the thin one was 1¾″, or a difference of ⅛″. This gives some idea of the strain that is always in castings that are not made of proper proportions, and also shows the difference there is in the contraction of thin and thick bodies of iron. These simple tests are such as any one can make.

To test the difference of strength between a casting poured with hot iron and one poured with dull iron, I made two bars, and poured one with the iron hot, and then stirring and mixing up the rest of the iron with a rod (so as to work up the impurities in the iron to the surface) until it was as dull as would run with safety, I poured the second one. The next day I took the bars and resting ¼″ of each end on a good, solid iron bearing—the one that was poured with hot iron first—commenced by putting on 50 pounds scale weights in the middle of the bar. Eight pounds were piled on, but before the weight of the ninth one was all on the bar broke.

Now, taking the bar that was poured with dull iron, the whole nine weights were piled on, and an additional 60 pounds' weight, the whole resting on the bar about eight seconds, when it broke. That is, the one poured dull broke with 510 pounds, while the one poured with hot iron broke with a weight of between 400 and 450 pounds. The size of these bars was 1″ square and 4 feet 6″ long.

Often a man will go to a foundry to get a bid on some plain plates, and thinking that the foundry man will put poor iron into them, he will ask for a low figure. He gets his low figures; also gets the poor iron in his plates. Common plate castings require as good iron as the common run of machinery castings; in fact, there are very few castings made but should have fairly good iron put into them, with the exception of such pieces as sash weights.

Often plates are made with holes to lighten them, or for some special purpose. When holes are made in castings for lightening them, the castings will be stronger for having the holes round, oblong or oval, instead of having them square. Sometimes, when square holes are made in castings, they will crack, as shown at *P*; whereas, if the corner is rounded, as shown at *A*, it will not crack. A heavy rib *X*, cast on to strengthen square holes, will often do more harm than good, as it causes a strain by making the casting disproportionate.

I have seen castings having on them heavy projections, flanges or ribs crack, that, were they cast without these parts, would stand a great blow or weight upon them before cracking or breaking. Cracks generally start from some thin or sharp corner, and, when once started, run through the entire body of the casting, the thick portions offering no more resistance, apparently, than the thin. A moulder, when making a new casting, should study the points or sharp corners that will be subject to strains, or disproportionate contraction; and, if possible, have the sharp corners made rounding, and the thin or thick portions made heavier or lighter. Should he be told that it will not do to change these parts, he then, should the casting crack (providing that he has done all that he could to uniformly cool it), is not be held responsible. Often castings crack that would not, had the heavy portions been exposed to the air as soon as they would admit of it.

Some may say, with better iron, the casting would not crack. This is all true enough in many cases. A good, strong iron, having very little contraction about it, would almost make a surety of making a casting of extreme proportions without liability of cracking; but this is not the kind of iron we usually have to deal with. Of course, the pig-iron merchant tells us his iron is possessed of all these qualities, and, not having means of knowing till we buy a car load or so, which is never found better than recommended, but which on hand must be used.

The best brands of iron that can be had will never have two shipments alike. The trial lot may be very fair, on the strength of which you may make a large order, which, when received, will very seldom be as good as the first.

The cut shown of a fly-wheel, having the hub split between every arm, is a good plan to adopt when making large pulleys, fly-wheels, or gears having cast-iron arms. A wheel made in this way can be relied on. Each arm being a separate casting by itself, when it contracts it is free from any strain or pull, as is the case when the hub is made in one solid casting. Castings made this way are banded with wrought rings, and the opening in hub filled with babbitt.

When a wheel of any description has cast-iron arms, rim and hub all one piece, there is generally a strain on the arms or rim of the wheel, in extent depending on the proportion of the rim and arms. If the rim is light and the arms heavy, we may look for a cracked rim, caused by the thin rim contracting faster and more than the arms. Again the arms will be the part to crack, caused by the rim being too heavy. In either instance, this generally happens while the casting is yet hot and in the sand.

In the case of pulleys, etc., having the arms crack after the casting is taken out of the sand, we have a more complicated state of affairs to deal with. In pulleys having heavy arms, compared with the rim, we often see the heavy arms cracked, the light rim remaining whole. In looking at such castings, it will be observed that the hub is heavy in proportion to the arms and rim. This hub is the last portion of the pulley to become solid; the rim, being light, has become solid, and is already contracting, driving before it the half-molten arms into the yet liquid iron in the heavy hub. When the hub solidifies, it contracts, pulling with it the arms, causing a strain, which, when the pulley gets a slight jar, will make the arms crack at the weakest point.

The same principle is involved in light-armed pulleys as in heavy ones; that is, so far as the heavy hub is concerned.

When there is a heavy hub required, it should be cooled as soon as possible by striping around it, taking out the core, and cooling with water.

Above everything, as regards the contraction and cracking of castings, we should not forget that a thin body of iron will contract more than a thick body, and, whenever there is a casting formed disproportionately, there is always more or less strain on some portion of it.

Lubricating Bearings.

By Lewis F. Lyne.

In the American Machinist of November 1, 1879, I endeavored, in the following language, to describe some of the inconsistencies of manufacturers and persons having charge of machinery in the improper selection and use of lubricants:

"It is impossible for a bearing to run cool until the high places are reduced, so that there will be a uniform film of unguent between the two surfaces. It is a custom for purchasing agents, and in some cases for practical men, when ordering oil, to mention simply 'lubricating oil,' without specifying the kind of bearings for which it is to be used. The latter is a very essential point. Frequently, when the oil is received, it is found to give poor satisfaction, and some of the bearings are found to run hot. Under these circumstances, the oil is generally charged with the fault, when, in reality, the fault has been in giving the order. A good lubricant for small, close fitting, fast-running bearings must be of a very fine quality, and have a light body in order to distribute itself between the close-fitting surfaces. Such a lubricant is entirely unfit for large bearings, where more body is required to carry the heavy weight which is placed upon them. It is the practice in most shops to use the same kind of lubricating oil for all the machinery, which, when properly considered, is both unreasonable and extravagant, for the reason that a bearing, when imperfectly lubricated, is worn away much faster than it would otherwise be, and on fine machinery the lost motion in the bearings requires frequent attention."

Experiments are constantly being made with a view of producing a cheaper lubricant than the best oils now known, and which shall possess all their desirable qualities as lubricators. For heavy shafting the journals are generally lubricated either by means of oil boxes or cavities in the upper part of the cap of the journal, so that tallow, grease, oil or other lubricant may be placed therein. The old way was to fill the oil box with tallow, leaving a small space for oil; and, in case the box should heat, the tallow would melt and run down over the journal.

I remember some years ago in a mill, there was a wall box supporting a five inch shaft which would get hot and remain so in spite of all the efforts made to cool it. Oil, sulphur and tallow, water, were each used in great abundance, but still the journal refused to surrender. Finally, one night I raised the shaft and removed the composition box, and had it carefully cleaned. The shaft having also been cleaned a very light film of lamp black was applied to the shaft, after which the box was gently rubbed over it. This test revealed the fact that the bearing was all right so far as fitting was concerned, but the surfaces of both the shaft and box were rough, and the skin of the metal disturbed. The load upon the bearing being heavy it was sure to heat. I obtained some pure flake graphite, and having melted a pot of pure tallow, I stirred in a liberal dose of the graphite. The box having been replaced, both bearing surfaces were covered with the mixture of graphite and tallow, and the shaft lowered to its place. In the morning when the machinery was started the box warmed up to about a blood heat and remained so for several hours, after which it cooled down and gave no more trouble. In a few days it was examined, when the surfaces were found polished like a looking glass. The graphite had become imbedded in the pores of the metal and formed a very fine wearing surface which ran with very little friction. I have since made use of this mixture for cooling heavy journals and have always found it successful. I have also used graphite mixed with oil for lubricating purposes, but have experienced difficulty from the graphite separating from the oil. I understand, however, that quite recent experiments have resulted in a chemical combination of oil with pure

graphite, so perfectly that they fail to separate after standing quietly in a vessel for months.

In using oil for lubricating a line shaft I prefer to use automatic oil cups, except in cases where self-oiling boxes are used. I believe the latter plan to be the most economical. The boxes should have wipers so as to exclude every particle of dust which mingles with the lubricant and scratches the surfaces of the journals. The great cause of the journal bearings upon railway cars being worn away is the fact that dust is freely admitted to the bearings, mixes with the oil and destroys the journal. I have known absolutely tight boxes to run until the wheels had to be renewed, simply by the addition of a little pure oil occasionally.

With automatic oil cups I have known journals to run with from 35 to 40 drops of oil per week, and have all the lubrication required. In many shops a "doper" is required to oil up the shafting every other day, and, as a rule, each time he oils up more than as much oil is wasted as would be required to run a month. The best oil judiciously used will in every case prove the cheapest and most economical in the end.

New Parallel Bench Vise.

In the shop, the use of some form of vise in which the motion of the movable jaw is such as to keep the clamping faces at all times parallel, may be said in this country to be universal. It needs no argument to demonstrate the superiority of such a vise over the old fashioned affairs, which have become in the machine shop objects of curiosity rather than tools for use. The parallel vise, although for a time considered reasonably complete in itself, naturally led to the providing of means whereby the distance between the jaws could be more rapidly adjusted than it could be by the operation of the screw, which if made of coarse pitch provides for too little clamping power, and if of fine pitch makes the operation of moving the jaw tedious in the time consumed.

The means provided for the rapid adjustment of the movable jaw have been various, one of which is that represented in the accompanying engraving of a vise just brought out by John Thomson, of 9 Spruce Street, New York.

This vise in its general features is neat in appearance, presenting no unsightly arrangement of parts to bring about the desired ends. Referring to the engraving it will be seen that the two jaws are connected and guided together by two parallel rods. The lower side of the upper rod is suitably flattened, and provided with ratchet teeth. A pawl which is situated inside the back jaw engages with these teeth, but is disengaged at will by the operation of either of two handles, one of which is shown at the side of the back jaw, the other being situated on the opposite side. When thus disengaged the front jaw is free to be moved to any desired position, where it is instantly clamped by the motion of the handle to its normal position, as shown.

The outer end of the upper or ratchet rod (inside the movable jaw) is a nut, in which the clamping screw works, operated by the lever shown, in the ordinary manner. By means of this screw the front jaw may be moved a distance of 1½", but since, for obvious reasons the necessity for more than a slight movement of this jaw by the screw is not required, the pitch of the screw is made ⅛". This fine pitch insures the firm clamping of whatever is being held between the jaws, by the application of a moderate pressure on the handle. A stop motion is provided in connection with the ratchet rod and clamping screw, so that the screw cannot be so far removed from the nut as to leave insufficient thread to suitably hold without danger of stripping.

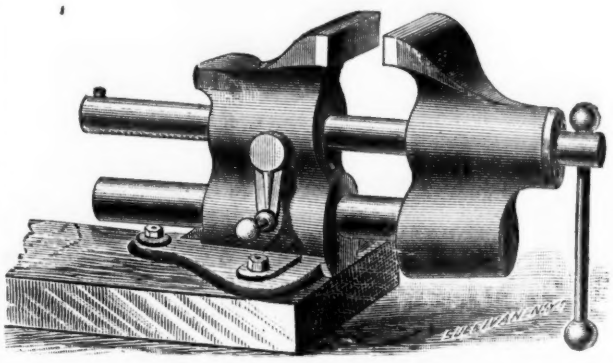
The lower rod is accurately and rigidly fitted in the outer jaw, and guided through the hole in the inner or fixed jaw.

The two rods named, as well as the ratchet spindle, pawl, pawl shaft, screw and lever are of steel. The faces of the jaws are steel welded on in the mould.

This vise is being made by special machinery and is, we are told, absolutely interchangeable in all its parts.

New Machine Tools.

We present herewith engravings of two machine tools, recently brought out by R. W. Rexford, 11 N. Sixth Street, Philadelphia, Pa. The power drill is designed for small and medium work. It is adapted to being



NEW PARALLEL BENCH VISE.

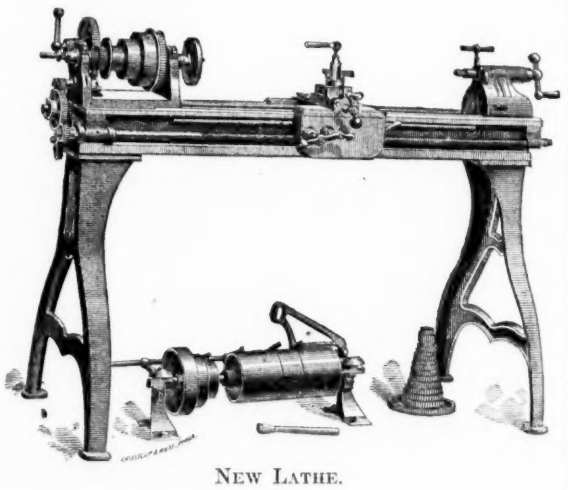
fastened on the bench, or may be otherwise conveniently located. Its capacity is 5 inches to center and to drill a hole one inch deep.

The spindle is of steel, fitted with Morse taper. The lever feed is provided with an easily-adjusted depth gauge, which is very convenient for drilling holes to a definite depth. One size is made 7¼" swing.

The driving belt passes over the idle pulleys and thence to the spindle pulley, and in operation when the lever is released a quick-return motion is brought about by the tendency of the belt to bring the pulley on the spindle even with the idlers.

The engine lathe swings eleven inches over the bed, 7¾ inches over the carriage and will take 3 feet between centers. The head spindle is large and has a $\frac{9}{16}$ hole through it for convenience in working long stock.

All sliding surfaces are accurately scraped to a bearing, the lead screw is of steel with open nut and screw gauge in carriage; countershaft, hangers, screw gears, wrenches, etc., complete.



NEW LATHE.

NEW LEVER DRILL.

The new catalogue of the American Society of Mechanical Engineers has just been issued. It gives the names and addresses of a total membership of 294, divided into five classes By the time this reaches the majority of our readers, over 20 more candidates for admission will doubtless have been added to the membership. In looking over the pages we notice that 23 States are represented in the Society. They are: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania Delaware, Maryland, Louisiana, Ohio, Michigan, Kentucky, Missouri, Indiana, Illinois, Wisconsin, Minnesota, California, Nevada and Colorado, also the district of Columbia. The foreign representatives in the society hail from England, Scotland, China, the Provinces of Quebec, Ontario and Manitoba. The growth of this young society in nunmbers and influence has surprised even its most enthusiastic friends.

The Society of Electric Light Engineers, has been organized in Brooklyn, N. Y., composed of engineers employed to run electric lights. M. Manning, is president, and Geo. B. Steubler, secretary.

It is reported that 70 new organizations have been perfected in Chicago for manufacturing purposes; and that the aggregate capital is over $22,000,000.

The *Textile Manufacturer* says: "Reducing the tax on whiskey and tobacco will not reduce the price of drinks and cigars." This, perhaps, explains why our contemporary does not favor the reduction.

The *Parisian* says that the establishment of a metropolitan railway in Paris is the object of severe criticisms on the part of many. It is said that an elevated railway will spoil the perspective of the boulevards which have been obtained at so much cost, while an underground railway will impair the solidity of the houses and interfere with the sewers and gas pipes. According to the project now under consideration, the railway will be a daylight route. Paris alone will be traversed by cuttings and tunnels, and the longest tunnel will not exceed 1,840 metres. Compressed-air locomotives will be used, and the train will consist of one first-class and three second-class carriages, carrying 284 passengers.—*N. Y. Evening Post.*

Soap Water (Suds) for Wire-Drawing and Metal Cutting.

The London *Mechanical World* of March 25th, has an original article under the above title from which we make some extracts as follows:

Soap for making "suds" for brass, copper, and steel wire-drawing, and for other purposes as lubricating and cooling the cutting tools in a machine or fitting shop, is in daily use by many of our readers. Some study of this subject, therefore, from a chemical, as well as a practical point of view will doubtless be of interest to such persons.

All kinds of soap, both hard and soft soap, are variously used for these purposes in different establishments, mixed with water in varying proportions, and with different kinds of oils. The most suitable soap, however, to use, is a pure potash soap, as nearly neutral as possible—that is to say, containing no free or unsaponified alkali.

There are various reasons why soft or potash soap is far superior to a hard or soda soap for these purposes In the first place a pure potash soap is naturally much more soluble than soda, or, generally speaking, white soap, besides being softer and more emollient, or of a more unctuous nature. One pound of pure potash soap, dissolved in four times its weight of water, forms a thin oily liquid, flowing perfectly when quite cold, and is of itself, without further addition of oil, for many purposes, a first-class lubricant.

* * * * *

For making suds for cutting metals, wire-drawing, and other similar purposes requiring a good lubricant, the soap is used chiefly to keep the oil in suspension in a certain amount of water added, to prevent the oil heating when subjected to the extreme pressure of the cutting or wire-drawing operation. Less potash soap is required for this purpose than soda soap, as, owing to its greater solubility, a given weight of potash soap will keep a much larger quantity of oil in suspension than the same weight of soda soap.

* * * * *

It is very difficult, however, to obtain a soap fulfilling these conditions. They are, in the first place, all more or less adulterated, and none of them are neutral, but all without exception strongly on the alkaline side—that is to say, containing an excess of free potash. This is very objectionable, especially in the case of brass or copper wire. Zinc is readily attacked and dissolved in a solution of caustic potash or caustic soda, and copper also is acted upon, though to a much less extent. The action of the free alkali, therefore, has a tendency to dissolve the wire in the act of drawing, and this is materially assisted by the enormous pressure which it then undergoes, thus interfering with the facility with which it can be drawn by forming a clogging mixture.

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If a really first-class pure potash soap cannot be obtained, engineers, wire drawers, and others requiring the most suitable soap for making their "suds," will generally find it both cheaper and better to make their own soft soap

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The following directions are all that is necessary for its manufacture: Take 20 lbs. of pure caustic potash, put it in any iron or earthenware vessel with its own weight—that is to say, two gallons of soft water. It will dissolve almost immediately, heating the water. Take ten gallons of oil, slightly heating it until warm to the hand – say about 140° F. This is most easily done by heating up to boiling point a small portion of the oil, and adding it to the rest of the oil used. Now, pour a caustic potash ley into the oil, in a small stream, with continuous stirring with a flat wooden stirrer, about two or three inches broad; continue to stir until the oil and ley appear well combined and smooth in appearance—ten to fifteen minutes will be enough. Put away the mixture in a warm room, covering well up with blankets or wooden rugs, to keep in the heat caused by the mixture slowly combining and turning into soap. Wrapping well up, so as to keep the temperature uniform un il the saponification is completed, is very important.

The mixing may be done in a wooden vessel. Half an old oil barrel answers the purpose well. After three days the soap is formed and ready for use, the quantity being about 120 pounds, though it is generally better to stir up well again and leave it standing, covered up, in a warm room for three days more. This insures the perfect saponification of all the oil, if any of it has separated from the ley after mixing, which is sometimes the case.

* * * * *

With reference to the best kinds of oil to use for wire drawing, nothing exceeds a really first-class pale seal oil, and this also saponifies well. A really good refined cotton-seed oil may be used for soft soap making, and it is also the cheapest oil in the market, though this oil is very inferior to pale seal oil when added to the soap and water to make suds, though for the simple production of these soaps for wire drawing it answers well.

* * * * *

A mixture of six gallons of soap, with the addition of eight gallons of water and three gallons of oil, is recommended for wire drawing. It may be conveniently mixed by putting it into a wooden bucket, with two gallons of hot water from condensed steam, and the soap dissolved by beating and stirring with some wires bundled together. Then add the rest of the water, and afterwards three gallons of best pale seal oil. It should be so thoroughly mixed that after standing the oil will not separate.

Adaptations of Overhead Traveling Cranes.

We present herewith illustrations of two devices, designed to add to the convenience and economy of operating machine and other shops, where considerable weights are to be moved from place to place.

The first illustration shows a single track, composed of *I* beams, which are bolted to the rafters overhead. A trolley of peculiar form is fitted to run on the bottom flange of this *I* beam, and to the bottom of the trolley is attached a Weston differential pulley block. When it is desired to transfer a load from one point to another, it is raised by the pulley block to any desired height, then pushed by the operator to any other point on the track. As the differential pulley block always holds its load at any point without running down, the same man that lifts the load can let go at any time and push the load along.

The Yale Lock Manufacturing Company, of Stamford, Connecticut, which has put up a number of these tracks, has adapted the tracks to a great variety of purposes. In some cases switches are provided so that any point in a shop can be reached by means of the tracks. This construction is adapted for loads up to 4,000 or 5,000 lbs. It is only adapted, however, for removing loads from point to point almost immediately under the track.

Where it is desirable to cover a considerable space, the construction shown in the second illustration is adopted. This consists in providing longitudinal tracks, on which runs a bridge, giving motion in one direction, and a trolley, as before described, running on the bottom flange of the bridge, giving motion in the other direction. The resultant of these two motions is, of course, a diagonal line, so that a load can be picked up at any point between the longitudinal tracks, raised to any desired height and deposited at any other point.

In the construction shown in the illustration the tracks are supported by wrought iron hangers, bolted to the beams overhead. These hangers may be made of any length desired, so as to avoid shafting or belting, or they can be designed with special reference to giving the greatest amount of headroom, which is found desirable in shops where the ceilings are low. The track may, in some cases, be supported on brackets fastened to the sides of the building, or by posts. The bridge is provided at each end with a two wheeled truck, and all the parts are nicely adjusted so as to diminish the friction as much as possible, and to enable the traversing of the bridge and of the trolley to be performed with as little labor as possible. This construction is adapted to loads up to 5,000 lbs. and for spans from 12 to 15 feet. For greater spans the Company uses its Weston traversing gear.

The illustrations described, show two types of apparatus which the Company has adapted, by ingenious modifications, to a great variety of situations and uses.

Purifying Lubricating Oils.

A German chemist, M. Kœllner, makes use of the following process for purifying lubricating oils and so renders them fit to be used again: He first puts the liquids into the lower part of a reservoir, closed at the top by a perforated lid; the residue is deposited at the bottom. By raising the reservoir at one end the oil passes into a second reservoir, then into two boxes joined together, filled with very clean cotton waste, and separated by a vertical perforated plate. The air circulates freely in the different apparatus, and the oil is then in a condition to be used immediately.—*Mechanical World.*

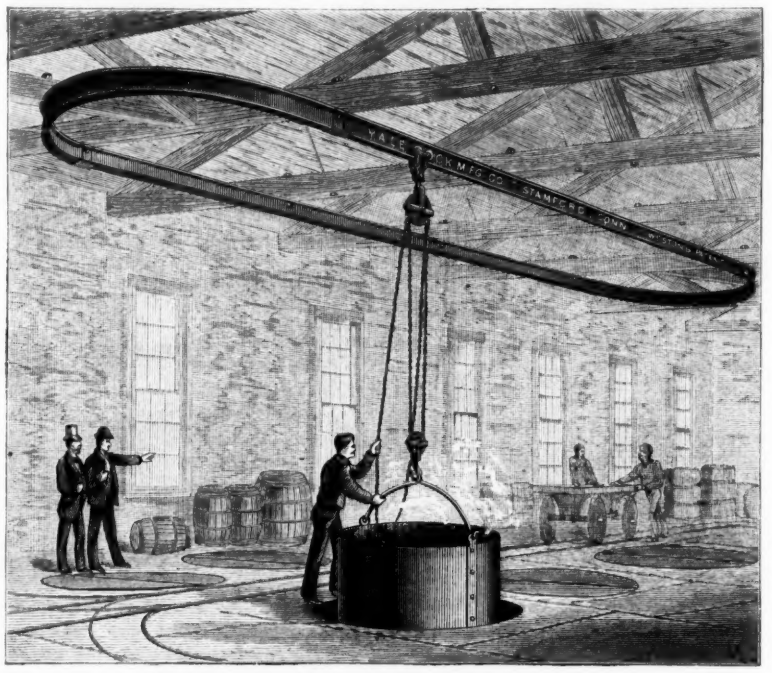
A Mount Holly, N. J., turbine manufacturer has received an order from Dublin, Ireland, for a water wheel to supply power for generating electricity on the Giants Causeway elevated tramway.

Comparisons Between High and Low Speed Engines.

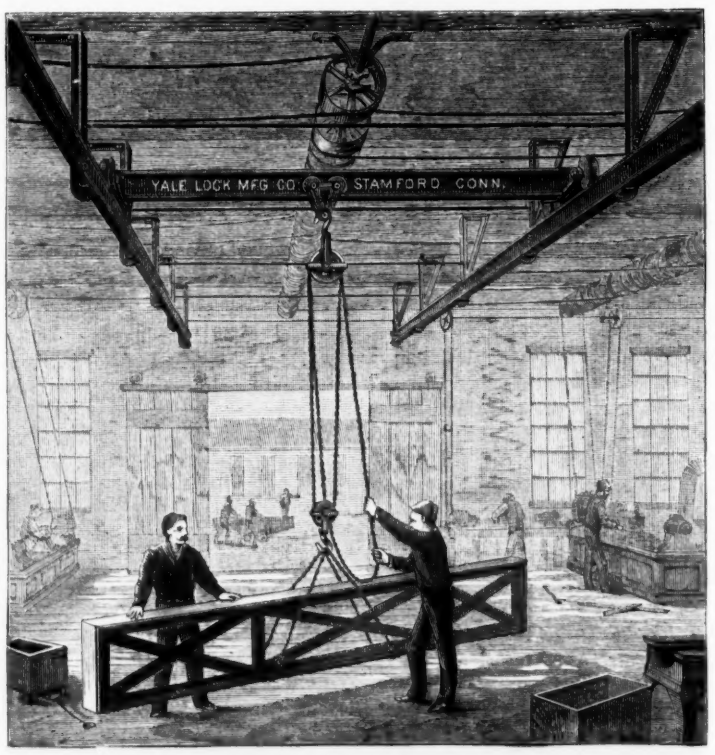
By Chas. A. Hague.

VI.

The term "positive," as applied to valve gear of that class in which the communication with the valves is at all times maintained, is really more of a distinguishing term, than a strict designation conveying the idea that such valve gear is actually any more positive in operation than the detachable type; indeed it would not be very difficult to show that the drop cut off is the most positive, all things considered. When the catch has engaged with the valve arm, and the valve is about to uncover the steam port, the connection is continuous, complete and invariable all the way to the eccentric, so that the induction of steam will always take place the same at every revolution. When the catch is disengaged by the regulator stop, what is there any more positive or certain than that the port will be promptly closed? The apparatus is as positively connected as the ordinary slide valve arrangement, until it is desirable to have it disengaged.



Single Track Overhead Traveling Crane.



Overhead Traveling Crane with Bridge and Trolley.

When, as in some forms of so-called "positive" valve gear, an automatically adjustable eccentric upon the crank shaft, is subjected to the tension of a spring in one direction, and to the centrifugal force of one or more suitably pivoted weights in the opposite direction, the position of the eccentric and the general nature of the arrangement is not strictly a positive one; and in automatically governing the engine the friction of the valve or valves, their connections and also of the apparatus itself is opposed to the regulating faculty. Also in "positive" valve mechanism, in which is employed a link and sliding block, the angular positions of the link with reference to the line of the valve connections, is such as to throw considerable holding stress upon the regulator; and as the conditions affecting friction, lubrication, &c., are liable to vary, it would seem as though the engine, if not suffering from what might be termed unsteady speed, may be liable to run at slightly different speeds at different times.

We do not, of course, intend to maintain that high speed engines must necessarily be fitted with the continuously connected valve mechanism, but as the leading specimens of that class of motor appear to-day, they are invariably so furnished; and the low speed representative machines are as regularly provided with the detachable motion. Indeed it is a very doubtful undertaking to attempt to operate a low-speed engine with any of the so-called positive devices, with the object in view of anything like steadiness of motion.

One more striking point of difference between these two classes of valve gear, is found in the availability after the full range of cut-off has been reached. With the continuous devices, after the limit of cut-off has been obtained, no more steam can enter the cylinder in case of sudden or unusual necessity in rolling mill work and in similar situations; whereas with the detachable method when the expansion limit has been exceeded, the induction valves are held open throughout the stroke, and thus keep the engine up to speed under circumstances which otherwise might result in a stoppage. Also when a large engine belted to a heavy load is shut down, unless some provision is made independent of the normal positions of the valve mechanism, with the "positive" gear, the limits within which the engine must be handled are quite close; but with the detachable gear a start may be made from any point in the stroke that would be practicable with an ordinary slide valve engine.

And now, in summing up the case in these comparisons, the only really tangible advantage to be presented by high-speed engines is the production of a certain power by means of a machine of lower first cost. If this can be successfully accomplished, then a point may be gained; but lower first cost, even down to one-half, is no compensation for an engine that will not wear well. The integrity of a steam engine, as a machine, is the leading factor in the matter; steam economy is of secondary consideration. After our high-speed engine has proven itself to be enduring at a lower cost, it must equal the economy of the long stroke in steam consumption before any gain will be apparent.

The mere fact of swift pistons or rapid revolution is no guarantee of steam economy. We have instances of very high duty being performed by engines of high-piston speed and very slow rotative speed, and also by those of slow piston movement and quite moderate rate of revolution, showing that we have simply to suppress condensation within the cylinder, and prevent leaks by appropriate means, to render steam consumption independent of engine details. If an engine cylinder were to be boxed in, so that the radiated heat could not diffuse itself into the atmosphere, we should probably find that the heat passing through the protection of well-guarded cylinders was sufficient to raise the temperature of very many pounds of water per day quite considerably above the melting point of ice; and, according to the theory of the mechanical equivalent of heat, every pound of water thus raised one degree represents 772 foot pounds of work.

There is a grand mystery yet to be solved by steam engineers, viz., why it is that the water in the boiler, having absorbed such enormous values of latent heat, holds tenaciously to it even down to the lowest pressure to which expansion can be carried in condensing engines? Steam entering a cylinder at a pressure of 135 pounds per inch above the atmosphere contains 1,191 heat units per pound weight; while steam at one pound pressure above absolute vacuum is charged with 1,112 units—a difference of 149 pounds in absolute pressure, and only 79 in heat units. But the instant complete condensation takes place the resulting water holds but a trifle more than 69 units per pound. If the theory is correct, the thing to do is to transform the heat into work, instead of allowing it to run away in the water.

Shop Kinks.

No. 30.

By L. F. Lyne.

How to Hang Grindstones and Emery Wheels.

In fitting up the shaft and boxes for hanging a grindstone, the shaft is generally turned up and one of the collars shrunk on. Should this collar work loose, it is prevented from sliding on the shaft by a shoulder. The other collar is bored to shift over the shaft, and is adjusted by means of a nut fitted to a thread upon the shaft.

In some instances, this collar and nut are in one piece. The shaft boxes are usually bolted to flat surfaces upon top of the grindstone frame or box. When a grindstone is purchased, if measured with a pair of calipers around the hole, it will be found

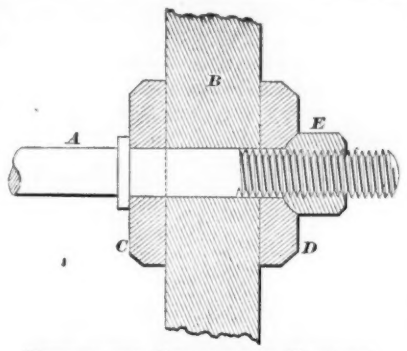
considerably thicker upon one side than upon the other. In hanging the stone, a square plug is fitted and driven into the hole; the center is then found with a pair of trammels, and a hole bored to admit the shaft. The loose collar and nut having been applied, the stone, with the shaft in it, is then placed upon the bearings, and trued by driving wedges or placing "shims" between the collars and the stone.

When the stone has been made to run satisfactorily, the nut is tightened with a large wrench. It is this last operation that I wish to talk about, and characterize it as the worst and most barbarous part of all the details described.

I doubt if there is a man living that could screw up the nut upon a grindstone shaft without springing or bending the shaft. Why this is so may be easily seen in the fact that when the collar and nut are in one piece, and the grindstone being of an uneven thickness, in tightening the nut the shaft must necessarily be sprung. Likewise when the collar and nut are separate, the flat face of the nut pressed with great force against a flat face upon the collar and bearing only upon one side, will produce a similar result. The effect of this is to cause the boxes to heat and wear flat places in the shaft.

Some people may suggest that this is getting down almost too fine for grindstones; but what has been asserted herein regarding grindstone shafts is also true when applied to emery wheels. Collars and nuts with flat faces are placed upon the spindles of emery wheels, which, when tightened upon the uneven surfaces of the wheels are sure to spring the spindles. This I know from experience, having seen it done by others and have done it myself. I have also had the satisfaction of applying an infallible remedy which is shown in the accompanying illustration, where *B* represents a section of an emery wheel, *A* the shaft and *C* the tight collar, while *D* is the loose collar and *E* the nut. To prevent springing the spindle when the nut is tightened I simply rounded off one face of the nut and dished out the loose collar, so as to form what is commonly known as a ball joint.

A workman may screw up a nut of this kind until it strips the thread without the least danger of springing the spindle, regardless of how uneven the surfaces of the emery wheel may be. I have never seen this device upon any of the grinding machinery in the market. I believe that it is not patented; at least, every one has a right to use it, so far as I am concerned.



Device for Grindstone Hanging.

Carrier Pulleys—Shaft Hangers and Boxes.

We present with this some devices for use in connection with shafting, and the transmission of power by belts, manufactured by C. C. Klein, of the Cambria Shafting and Machine Works, Marshall and Cambria streets, Philadelphia, Pa.

Of these, Figs. 1 and 2 represent an improvement in carrier pulleys and frame, which is intended for universal application, doing away with especial construction for different purposes, and simplifying the application of such devices.

This arrangement is applicable in the connection by belt of two shafts without reference to their relative positions; that is, the two shafts may make any angle with each other, and at the same time may be on the same or different levels. This result is accomplished by such an application of universal joints as permits the adjustment of each pulley in either plane, without disturbing the adjustment with reference to the other plane, or with reference to the other pulley, the belt driving equally well in either direction, and with the least possible loss from friction.

Fig. 3 represents a drop hanger and Fig. 4 a post hanger, in which the box is pivoted by means of ball and socket arrangement, in which a segmental portion of a threaded nut serves the purpose of raising or lowering the box, and, in connection with the screw or bolt shown in the engraving, of firmly locking it in position.

Fig. 5 shows a ball and socket pillow block.

These boxes are provided with automatic lubrication of the kind in which the oil is fed to the journal by capillary attraction. The especial construction for this purpose is such that the box and reservoir, or oil cellar, can be conveniently cast in one piece, doing away with the cost of bolting the one to the other, the extra metal required, and the possibility of leaky joints. The reservoir is cast to one side, and only slightly below the level of the journal, thereby decreasing the vertical distance through which the oil must be fed by capillary attraction.

The general form and design of these various devices may be seen in the engravings.

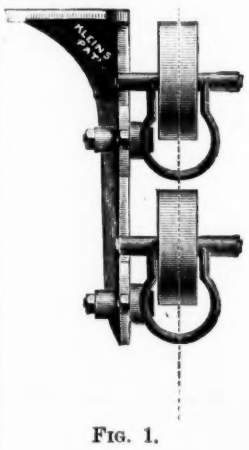


Fig. 1.

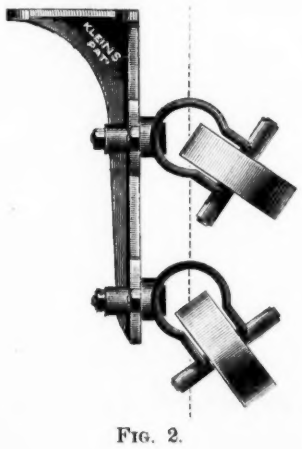


Fig. 2.

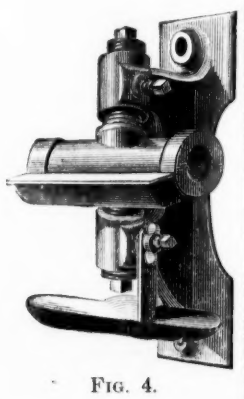


Fig. 4.

Fig. 3.

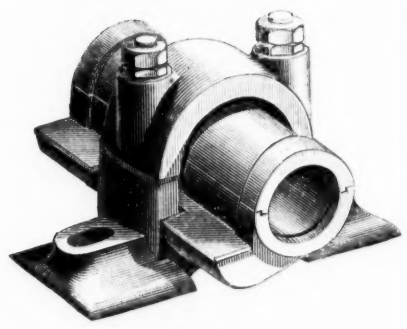


Fig. 5.

LETTERS FROM PRACTICAL MEN.

How to Understand Mechanical Matters.

Editor American Machinist:

Let me add a word to what has been said about the difficulty of an understanding by some of your readers of certain articles which you have published. It is that there are various kinds of language in the world, in common use among men, and that a writer is entitled to select which ever one he may prefer for the presentation of his ideas. No other rule can be adopted that will not lead to more baffling results than those complained of, for everywhere men can be found who do not understand all the languages they meet in print.

I do not understand German, but am I entitled to complain because a writer uses German, which he and many others do understand?

I have some knowledge of drawing (one of the forms of language) but shall I be denied the privilege of using it because some readers may find it extremely difficult to understand?

I believe the true thing to do when I find an interesting subject written in a language only partly known to me, is to seek diligently for a fuller knowledge of it, and honest effort will yield a surprising result in such things.

P. Barnes.

Springfield, Ill.

Pipe Thread and Pipe Tap Tapers.—A Discrepancy.

Editor American Machinist:

I have been trying for some time to get at the truth regarding pipe threads, and notice in one of your answers to questions you give the taper of pipe taps as 1" to the foot. A Boston company equally prominent with the one you mention make theirs $\frac{3}{4}$" to the foot, and say it is correct. At the same time the thread on a piece of pipe from the manufacturer isn't over $\frac{5}{8}$" taper, and fittings are tapped about the same. Now will some one be kind enough to explain the mystery? If $\frac{5}{8}$" is right for pipe, why should taps be $\frac{3}{4}$" and 1"? If a *manufacturer's* die is $\frac{5}{8}$", why should a *piper's* die be so much more? If I had a piece of pipe ready threaded at one end $\frac{5}{8}$" taper, and should screw it into a hole in my boiler tapped with a tap 1" taper, and should thread the other end with a die $\frac{3}{4}$" taper, and screw on a tee tapped $\frac{3}{8}$" taper, would it be a good job, and would I be justified by saying that these taps and dies were the only ones I could buy?

Greaser.

Boston, Mass.

Two Tapers for Pipe Taps—Which is Right?

Editor American Machinist:

In last week's issue a correspondent inquires as to the taper of gas-pipe threads. You reply that "you are informed by Pratt and Whitney that the taper is one inch to the foot." If Pratt & Whitney are correctly reported by you, I have to say that their standard is different from the standard prevailing in Philadelphia, and the rest of the country, Hartford alone excepted. In this city, the standard, as used by Morris, Tasker & Co., Pancoast & Maule, and, in fact, by everyone else in the business, is $\frac{1}{16}$th taper per inch, or $\frac{3}{4}$" per foot. The difference in the two tapers being, as you will notice, $\frac{1}{48}$th to the inch. The firm of Morris, Tasker & Co., are the originators of the pipe business in this country, and have furnished standard measurements and gauges to other firms innumerable.

If your correspondent should make his dies for threading pipe according to Pratt & Whitney, viz., $\frac{1}{12}$" taper per inch, and then purchase his fittings tapped according to the standard, $\frac{1}{16}$th taper per inch, I do not think he could make a joint that would remain steam tight very long, as the joint would be made by about two, or possibly three, threads on the pipe.

The taper I have mentioned is the standard for all wrought iron pipe, whether intended to be used for gas, steam or water. It is now in order for some one to stand up and explain the reason for the difference in standards, with a view of deciding which standard is standard, as to assume that there can be two different sizes, *both* standards in the same thing, is about as paradoxical as it would be to speak of two monopolies in the same line of business.

R. B. B.

Frankford, Philadelphia.

Montana—Its Business—Reversing Letter Casts.

Editor American Machinist:

Since you have commenced publishing my letters, I have received numerous letters from "*America*," inquiring all about this country, and the chances for situations for machinists, engineers, etc. These letters I have endeavored to answer to the best of my ability. I am not in the machine business; there are only a few machine shops in the Territory; the class of work done is repairing; at present very little new work is done. The principal work in repairing is on mowing, reaping and threshing machines, quartz and saw mills, and other coarse work. The most of the *engineers* called for are *engine runners*, who are usually paid about the same, or a little less, wages than ordinary day laborers. The country is new, and settling up rapidly. Plenty of good chances here for what we call *rustlers*. Any quantity of pilgrims coming here are seeking situations as bank presidents or cashiers, or are expecting to find gold or silver scattered around loosely, so as to be shoveled up by the shovelful into their pockets. To such I will say that the men to shovel up this gold into pilgrims' pockets all left here last year. Now it requires some little experience and good business management to secure fortunes at mining, which is the leading business. Situations as bank presidents are scarce.

There are splendid openings here for business men with capital in a great many lines. A properly-equipped paper mill would, I believe, make a fortune for the person or company who would start the business. The freight on the paper we import is about three to four or five cents per pound. No rags are now saved here; plenty of cotton-wood here for wood pulp. Chemicals would now have to be shipped in.

A pail and wash-tub factory would undoubtedly pay. A beet-root sugar factory would, I believe, pay immensely; and besides, under a law of the Territory, would be exempt from taxation for a number of years.

A woolen factory, or two or three would undoubtedly pay. We now ship large quantities of wool, and import all of our woolen goods.

There will be an immense business done here in packing meats, as we have, undoubtedly one of the best stock-growing countries in the world. Cattle and sheep seldom have to be fed winters.

No part of the world has better mines than Montana, either of gold, silver, lead, iron, coal, copper, zinc and many other minerals, and development can be truly said only to have just commenced

But I am wandering from mechanical subjects.

Now as it may be of some interest to your readers to know how Montana engineers (?) can manage, let me tell you an instance. Some three or four years ago I had some business with one of our prominent lumber men, and with him passed one of his saw mills, where he stopped to direct some matters. I went into the mill and found a rock pile with smoke and fire rolling out of it. Further examination showed that it was a locomotive style of boiler—rock furnaces had been built on both sides and the boiler was fired on both sides, center, top and bottom. The safety valve (?) was loaded down with all the scrap iron it would hold. There was a round thing on top, which upon inquiry, I found to be a steam gauge, or what had been one once; the glass in front was so covered with soot that it was absolutely impossible to tell from it anything about how much steam was carried. The engine was pounding away like a trip-hammer. I told

the proprietor that I would not work in the mill for a hundred dollars a day. He said there was no danger; that he always made his engineers carry plenty of water, and that a boiler would never, or had never, burst except on account of low water. The boiler was used in this way for more than a year afterwards, and finally moved to another place where it was left on the bank of a creek about a year to dry out. It was then pounded on the outside to jar off the dry mud on the inside Several bushels were so removed, and the boiler reset on an *improved* (?) plan. The boiler was turned tail end in front, a rock pile was built around it and all over it, completely walling in and covering in the safety valve. A grating of old water pipes was constructed so as to take in full length slabs; the fire led to the original front of the boiler, and back through the fire box and tubes, thence out through the smoke-stack.

I never had any curiosity to examine this new plan of setting boilers, but a friend of mine, an excellent mechanic, had occasion to to do some repairs about the mill. The front of the steam gauge had been cleaned off, and he found it registering 180 pounds. He asked the engineer how much steam was usually carried. He said, "about the same as we do now, sometimes more, sometimes less." My friend said that he made his stay as short as possible. He said he had no objection to being blown up by a boiler, but he did not want to get killed with rocks. I believe this boiler is still running, "doing good work."

It is necessary to say that Montana has no law in regard to inspection or regulation of boilers. Only a short time since I was speaking to the proprietor of the above described works, on the necessity of such a law. He said: "That's all humbug; we have been running mills for the last fifteen years, and have never had a boiler explosion. We carry from 180 to 200 lbs. steam, and there is not a bit of danger if you only keep plenty of water." I asked him if he ever tested his boilers; he said, "no, there is no use of that, they are tested in the shop when they are made."

I don't want any engineering job in such a concern; if any of your readers do, they are welcome to it.

I believe I have a new wrinkle which may be of utility to some of your readers, and will try and give it to you.

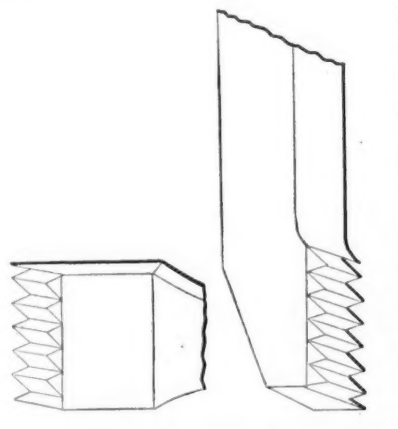
I have a friend who is as surely a mechanical genius as any man I ever saw. He is an amateur, but an excellent workman. He can do almost any job in a mechanical line, and what he does is done as well as if done by a professional. He is a type cutter, or rather at one time in his life he took up that business, and has some excellent specimens of his handiwork in that line. He is one of your old subscribers, Mr. H. M. Hill, of Clancy. He was showing me a few years since the process of making printing types, and showed me the punches used in stamping matrices. The beautiful work done upon these steel types or punches excited my admiration, and while discussing the subject I incidentally mentioned the fact that I thought type would, if properly transferred, make excellent patterns for casting a maker's card to be screwed to a machine; the only difficulty consisted in devising a process for reversing the type. A few days since I was at his place and he showed me how he had accomplished such a reversal. It is so simple, and of such evident utility for the purpose, that with Mr. Hill's consent I now give it away.

First: Set up a card with suitable type, if you have an engraved trade mark or cut of medal, put it in the card as set up. Then after the form is made up, justify it, plane down, &c., press it into a sheet of hard rubber of proper thickness which has been softened by heat; let the rubber cool under pressure until hard, then file off the face of the rubber until you get down to the level of the impression of the face of the letters, &c. You now have apparantly a flat piece of hard rubber. Now put this on a flat heated surface and the face of the letters, &c., will rise up showing a reversed impression of the type, beautifully adapted as a pattern for moulding. This pattern can be bent to any shape for attaching to a curved surface.

May be that this is an old process, but it was new to me and may be new and useful to many of your readers.

Geo. B. Foote.

Helena, Montana.



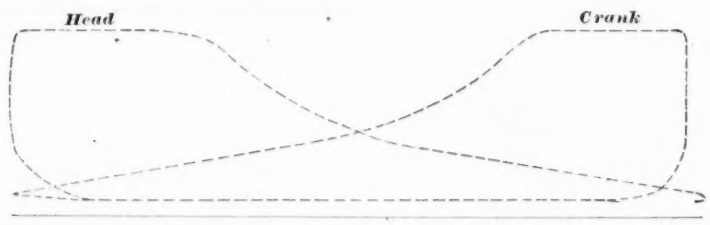
Device for Making Chasers.—Mr. Dicks asked to Explain.

Editor American Machinist:

In your issue of Jan. 21st, I noticed a device for making chasers, by W. Dicks, Toronto, Ont. When I read this I studied up the plan given as I do everything in the Machinist, and came to the conclusion that there was something wrong about it, or else I did not perfectly understand it; so at my first opportunity I have given the matter a test. I followed his plan in detail, and find that the male chaser would be a *right* thread, but the female chaser, would be a *left* thread. The sketch above will give a better idea of the result; or let any one take a common right hand chaser, first hold it in position to chase a thread on the outside of a cylinder and then hold it as though it were an inside chaser, and he will at once see the result for himself. Will Mr. Dicks please explain?

J. G. Xander.

Reading, Pa.



Indicator Diagram From Brown Engine.

Editor American Machinist:

Having seen the Indicator diagrams in your paper, in which I am much interested, I take the liberty of sending you a diagram from a Brown automatic engine owned by Whitehead & Atherton, of Lowell, taken by me April 1st. The engine has been run 1½ years without indicating. The card was taken without any adjusting of valve gear, and I think speaks well for the engine. The shop is heated with exhaust steam; back pressure gauge shows from 4 to 5 pounds.

Cylinder 15" x 36". Revolutions, 60 per minute; boiler pressure, 60 pounds.

Chas. L. Corbett.

Lowell, Mass.

Discussion on Melting Iron.

Editor American Machinist:

Mr. Kirk says, in your paper of March 25, that I set myself up as critic of all published works on the melting of iron. It is true that I have examined a number of works on iron melting, and I have given my opinion of them. I do no injustice to any author that I know of, when I say that any one unacquainted with the conversion of iron ore into pig iron, or the melting of pig iron for foundry purposes, who takes for his guide the so-called practical works on iron melting will find it impossible to make a success. I do wish it was otherwise, but the works themselves criticise the author, and sustain the truthfulness of my statements in this letter, and in my letter of February 18.

Mr. Kirk says I make the most extravagant claims he ever saw published, when I say I have melted 9¼ pounds of iron to 1 pound of fuel. Now, if Mr. Kirk had said that I made the most economical claims, there would have been some sense in the little figuring he tells us he has done. If the circumstances were as he tries to make them, it would be impossible to melt iron; but he has evidently made a mistake in his figuring, for it is a well-known fact that 1 cubic foot of coke, broken small enough for cupola use, weighs 22½ pounds, and hard coal 50 pounds. Now, figure for yourselves, and see which is right. One hundred and thirty-five pounds of coke equals 6 cubic feet; 100 pounds of coal equals 2 cubic feet. Now we have 8 cubic feet of fuel on the bottom of a 24" cupola, and it will require 28" in height to contain it; therefore, we have in the cupola that I described in my letter of February 18, 17" of fuel above the tuyeres, in place of 9", as Mr. Kirk would have us believe.

To prove my figures, I put up the bottom of our cupola, and filled it with sand up to within 7" of the tuyeres. I then put in the 100 pounds of coal and 135 pounds of coke, and measured very carefully. I also had a few of the moulders, with our foreman in the foundry, measure it for themselves. We all agreed that we had 17" of fuel above the tuyeres, and, if Mr. Kirk will look into the matter carefully, he will find that he is mistaken. I hope he will be kind enough to investigate the matter, and acknowledge the same.

I ask all who are interested in the melting of iron to investigate the matter for their own satisfaction, and if you cannot figure it, and if your furnace is more or less than 24" in diameter, find an old piece of sheet iron, and out of it make a rough tube 24" in diameter inside and 28" high. Now, weigh 100 pounds of coal and 135 pounds of coke; break it into pieces, as you would for your cupola; put the coal and the coke into the tube you have made, and, if it fills it, then we have enough fuel to fill the cupola that I have described 17" above tuyeres.

Mr. Kirk says to follow the instructions of Mr. West I will find that I cannot melt 7½ pounds nor 7 pounds of iron to 1 of fuel. It would seem from Mr. Kirk's letter, and his statements *elsewhere*, that, if iron could be melted on as economical a plan as 1 of fuel to 7 of iron in cupola such as I described, it would be a new departure in iron melting. I can assure Mr. Kirk, and all others interested, that it is not a new departure; for in Scotland, where there are inexhaustible fields of coal, they have been melting iron for years to my own knowledge with 1 pound of fuel to 7 pounds of iron; therefore, any one who desires to try the above safe and economical plan can rest assured that they are not infringing on my rights.

I have no hesitation in saying that any foundry foreman who is using more than 1 to 7 is infringing on his employer's resources; and any author who will in his theory call for more fuel than 1 to 7 ought to engage himself for a short time to some iron company, and receive economical instruction on the construction and management of cupolas, that he may be more able to publish a work from a practical as well as from a theoretical standpoint.

If this letter does not convince Mr. Kirk that I am right, if he will come to Grinnell and call at the Header and Harvester works of Craver & Steele, I will show him that our cupola man is using no more fuel than 1 to 7, and melting excellently. If he will stop for a couple of days, I will take charge of the cupola myself, and will melt for him 9 to 9½ pounds of iron to 1 pound of fuel.

As Mr. Kirk is about to publish another work on iron melting, I believe it will be to his advantage to make us a visit.

Mr. Kirk says I admitted making a failure of my heat; but I can't see where, in my letter, he finds the admission. I said the amount of fuel I used was not a safe working amount; but I did take a good heat, as stated.

I have said there is no practical work on iron melting—and I know a mere assertion amounts to nothing—but, to show that I have faith in my statements, I am willing to enter into a fair investigation of Mr. Kirk's work on iron melting, if he is willing to defend it.

Jas. M. Wishart,
Foreman of Craver & Steele's Harvester Works.

Determination of Heating Surface Required in Ventilating Flues.

By Prof. W. P. Trowbridge.

A PAPER READ BEFORE THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The proper ventilation of a room requires the frequent removal of the vitiated air and the introduction of fresh air, the quantities by weight of the air ejected and the air introduced being equal. If the process be continuous and the proper amount of air be admitted and removed every hour, or minute, the only other requirements are that the entering air shall be pure, that it shall be properly warmed in cold weather either before it enters the room or by the mixture of warm and cold air in the room, and that the introduction and removal of air shall take place by gentle or inappreciable currents distributed in such a manner that the pure air may be thoroughly diffused throughout the room before it is removed.

These simple rules are easily stated and comprehended. It is also well understood that the movement of air requires force in proportion to the mass moved and the velocity which is imparted to it. The problems which arise in ventilation consist mainly in determining the position, arrangement, and size of the passage through which the air enters and leaves the space ventilated, and the adaptation to the passages or flues of the force or forces which produce the movement of the air On the solution of these problems, too often misapplied or misunderstood, successful ventilation depends.

The various means of producing the movement of the air are:—

1st. *Fans or Blowers*, requiring the use of machinery in driving them

2d. *Ventilating chimneys*, in which the movement of the air is caused by the difference in weight between the column of hot air in the flue and the cooler air outside. This requires necessarily that the air in the flue shall be warmer than that outside, and the necessary heat must be imparted to the air before it enters the flue.

3d. The movement of the air may be produced by *steam jets* in the flue, the particles of steam issuing at a high velocity, carrying with them particles of air and thus producing a diminution of pressure below the jet and a consequent movement.

The steam jet method is seldom used, the ventilating flues being generally employed. The most common application of the latter is the ordinary ventilating flue of dwelling houses. In this case reliance is usually placed upon the heated air of the room, which, finding its way into the flue, forms a vertical column lighter than the outer air and having a height equal to the height of the flues. An upward movement in the flue is thus produced.

The laws of the movement, involving the height of the flues, the temperature of the air in the room, the temperature of the outer air, and the velocity of the upward current, may in this case be theoretically determined; and from such a determination, taking into account the frictional resistances, the area of the cross section of a flue for the discharge of a given weight of air may be ascertained. Analytical investigations of this character are seldom made except by experts, and for ordinary dwelling houses the whole system is generally a haphazard construction in which the errors are quite certain to fall on the side of inefficient ventilation. Moreover the system cannot operate during those periods of the year in which the temperature of the outer air is the same or nearly the same as that of the room. During these seasons some other means must be resorted to in order to warm the air before it enters the vertical ventilating flues. The system is inefficient also, except with very large flues, owing to the slight difference, even in ordinary cold weather, between the temperature of the air in the room and that of the air outside

For very active ventilation, therefore, with such flues as may ordinarily be constructed, the air must be heated; and this may be done by several methods:

1st. By a stove at the base of the flue, the stove chimney passing up through the flue.

2d. By gas jets burning at the base.

3d. By coils of steam pipes in the chamber at the base of the flue.

All of these processes require careful analysis in their application, and may, to a certain extent, be subjected to such an analysis. The object of this paper is to investigate the laws which govern the ventilation when the air is heated by means of coils of steam pipe, before it enters the flue. These laws have not heretofore been developed, and as this system of ventilation is a very simple one, capable of extended application, it is hoped that the following analysis may at least lead to a full discussion of the subject.

Let it be supposed that the air in the room is to be renewed at the rate of W pounds per second. The volume of this quantity of air can easily be determined when its temperature is given. Suppose also that it is to be ejected through a vertical flue whose cross section is A and whose height is H, and that it is to be heated by steam coils at the base of the flue, having a total exterior surface equal to S.

The following notation will be used:

W = weight of air discharged per second.
H = height of flue.
S = the exterior surface of steam coil.
A = area of cross section of flue
T_a = the absolute temperature of the external air, *i.e.*, the common temperature Fahrenheit + 459.4°.
T_c = the absolute temperature of the air in the flue.
T_s = the temperature of the steam in the coils.
D_a = the weight of a cubic foot of the external air.
D_c = the weight of a cubic foot of the air in the flue.
V' = the theoretical velocity of the air in the flue.
V = its actual velocity when frictional resistances are taken into account.
r = the rate in units of heat per hour, for each square foot of the surface S, at which the air receives heat from the coil, and for each degree of difference between the temperature of the steam and the air of the room.
K = coefficient of velocity, such that $KV = V'$.
p = the unbalanced upward pressure at the base of the flue due to the difference between D_a and D_c, or due to the difference in weight between the two volumes of the height H within the outside of the flue.

The pressure per square foot, p, will then be represented by the equation,

$$p = HD_a - HD_c \text{ or } p = H(D_a - D_c) \quad (1)$$

This pressure may be represented by the weight of the column of the heated air, represented by

$$\frac{p}{D_c} = H\left(\frac{D_a - D_c}{D_c}\right) \quad (2)$$

The velocity with which the air would flow through the flue if there were no resistances would be determined by the expression,

$$\frac{V'^2}{2g} = H\left(\frac{D_a - D_c}{D_c}\right)$$

$$V' = \sqrt{2g\ H\left(\frac{D_a - D_c}{D_c}\right)} \quad (3)$$

But, from the Marcotte-Gay Lussac law for air,

$$\frac{D_c}{D_a} = \frac{T_a}{T_c} \text{ or } D_c = D_a\left(\frac{T_a}{T_c}\right)$$

Substituting this value of D_c in equation (3), there results

$$V' = \sqrt{2g\ H\left(\frac{T_c - T_a}{T_a}\right)} \quad (4)$$

In this expression the theoretical velocity is expressed in terms of the absolute temperatures of the air within and without the flue, and the height of the flue.

From (4) we obtain

$$T_c - T_a = \frac{V'^2}{2gH} \cdot T_a \quad (5)$$

The quantity of heat transferred to the air on its passage through or among the steam-pipes may be represented by

$$Q = W\,C(T_c - T_a) \quad (6)$$

in which $C = .238$, the specific heat of air at constant pressure.

All of the above formulas are well known; the following are believed to be new:

The quantity of heat imparted per second to the air by the steam pipes may be represented by the total exterior surface of the steam pipes (S) expressed in square feet, multiplied by the rate per second and per square foot at which heat is transferred to the air, or

$$\frac{Sr\,(T_s - T_a)}{3600} = Q'$$

and from the nature of the problem we must have

$$Q = Q'$$

or
$$\frac{Sr\,(T_s - T_a)}{3600} = W\,C(T_c - T_a) \quad (7)$$

from which we obtain

$$T_c - T_a = \frac{Sr\,(T_s - T_a)}{W\,C \times 3600} \quad (8)$$

Combining this equation with equation (5), we have

$$\frac{Sr(T_s - T_a)}{W\,C \times 3600} = \frac{V'^2}{2gH} \times T_a$$

and
$$S = \frac{V'^2}{2gH} \times \frac{W\,C\,T_a}{\frac{r\,(T_s - T_a)}{3600}} \quad (9)$$

This expression gives the total heating surface of the steam pipes in terms of the velocity, the height of the flue, the weight of air discharged per second, and the absolute temperature of the external air.

If we substitute for V' its value KV, the expression becomes

$$S = \frac{K^2\ V^2 \times W\,C\,T_a}{2gH\left(\frac{r\,(T_s - T_a)}{3600}\right)} \quad (10)$$

and since V is the actual velocity, we have

$$W = D_c\,V\,A$$

$$\therefore S = \frac{K^2\ V^2 \times D_c\,C\,T_a\,A}{2gH\left(\frac{r\,(T_s - T_a)}{3600}\right)} \quad (11)$$

A being the area or cross section of the flue. Equations (10) and (11) represent the laws connecting the heating surface with the height of the chimney, the area of the flue, and the temperature of the external air, They show that the heating surface is directly proportional to the cube of the velocity, to the area of the flue, and to the temperature of the external air, and inversely proportional to the height of the chimney and the rate of transfer of the heat, r, or $r\,(T_s - T_a)$.

To illustrate the practical use of the formula, let it be proposed to renew the air of a room containing 50,000 cubic feet four times in an hour, through a flue whose cross section $A = 12$ square feet, the height (H) being 50 feet. Required the number of square feet in the surface of the coil, the steam within the coil being maintained at 50 pounds pressure. Suppose, further, that the temperature of the air, before it enters the flues is 60° F., the same as that of the outside air.

The weight of a cubic foot of air at 60° F., or (D_a), is found as follows: The weight of a cubic foot of air at 32° F., and atmospheric pressure being known, viz.: 0.0808 pound, the weight at 60° F., will be

$$D_a = 0.0808\frac{T_o}{T_a}$$

T_o being the absolute temperature corresponding to 32° F. (or 32° + 459.4° = 491.4), and T_a be-ing equal to 60° + 459.4° = 519.4°,

$$\therefore D_a = 0.0808\frac{491.4}{519.4} = 0.0764 \text{ lbs.}$$

and the weight of 50,000 cubic feet at 60° F. will be

$$50{,}000 \times 0.0764 = 3820 \text{ lbs.}$$

As four times this weight is to pass through the flue in one hour, we have

3,820 × 4 = 15280 lbs per hour;
or 254.67 lbs. per minute;
or 4.244 lbs. per second.
$\therefore$ $W = 4.244$ lbs.

We also have

$T_a = 519.4$
$C = 0.238$

For the value of r to be used in the formula, an average of the results of the experiments made by Mr. C. B. Richards, at the Colt's Arms Co. at Hartford, may be taken for ordinary forms of heaters, it being understood that this value is assumed to be nearly correct, although the quantity (r) was found to vary in proportion to the quantity of air passing through the heater in a given time. Assuming the value of (r) to be 2.5 units of heat per hour per square foot of surface, and for each degree of difference of temperature between the steam in the coil and the air of the room, there results for the value of r per second,

$$\frac{r}{3600} \times (T_s - T_a)$$

With steam at 50 pounds,

$$T_s - T_a = 281° - 60° = 221° \text{ F.}$$

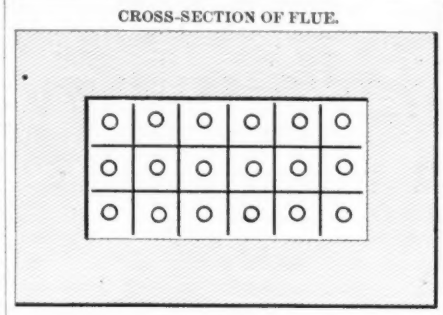
$$\therefore \frac{r}{3600}(T_s - T_a) = \frac{2.5}{3600} \times 221 = 0.153$$

All the quantities in equation (10) are now known for this problem, except $K^2\ V^2$. If we assume a velocity V, and also a correct value of K, the resultant value of S should be such as to give this velocity. Assuming $V = 7$ feet per second, and $K = 4$, the value of $K^2\ V^2$ will be $16 \times 49 = 784$.

In regard to the value of K, Peclet found in the ordinary boiler chimney of manufacturing establishments, for heights of 10, 20, and 30 meters, V' equal respectively to $5.6\,V$, $6\,V$, and $6.3\,V$. It may also be demonstrated that if the resistances were due to friction alone, the loss of velocity in a simple rectangular flue, 50 feet high and 12 square feet cross section, would be such that V' would be about twice V, or $V' = 2\,V$.

The interposition of the coil of pipe

CROSS-SECTION OF FLUE.



Scale ½
Inches 12 9 6 3 0 1 2 Feet.

through which the air passes, increases the resistance beyond that of the simple flue, but it cannot be so great as that developed in passing through the grate, flues, and chimney of a steam boiler.

I have taken for this example $V' = 4\,V$, *i.e.*, the actual velocity equal only to one-fourth of the theoretical, which will at least throw the error if there be any, on the side of excess in the value of S.

We may now recapitulate the value of the quantities in equation (10) as determined for this problem.

$K^2\ V^2 = 784.$
$\frac{r\,(T_s - T_a)}{3600} = 0.153$
$W = 4.244.$
$C = 0.238.$
$T_a = 519.4°.$

$$\therefore S = \frac{K^2\ V^2 \times WCT_a}{2gH.\ \frac{r\,(T_s - T_a)}{3600}} = 835 \text{ square ft.}$$

It now remains to ascertain what temperature and density the air in the flue will have.

The quantity of heat expanded per second will be:

$$S.\frac{r(T_s - T_a)}{3600} = S \times 0.153 = 835 \times 0.153 = 127.755$$

units. Per minute it will be 7,665.30, and per hour, 459,918 units.

To find the flue temperature (T_c) we have

$$Q = W\,C\,(T_c - T_a)$$

or
$$T_c = \frac{Q + W\,C\,T_a}{W\,C} = \frac{127.755 + 1.01 \times 519.4}{1.01} =$$

645.9°, corresponding to a thermometric temperature of 645.9—459.4 = 186.5°. This is the temperature of the air in the flue. Its density will be

$$D_c = 0.0808\frac{T_o}{645.9} = 0.0808\frac{491.4}{645.9} = 0.0761 \text{ lbs.}$$

per cubic foot.

The volume of one pound will be $\frac{1}{0.0761}$ = 13.14 cubic feet.

With a velocity of 7 feet per second there will be ejected through the flue of 12 square feet area, 302400 cubic feet, or $302400 \times 0.0761 = 23004.64$ pounds per hour.

This is in excess of the requirement, which was only 15280 pounds per hour.

If we assume a velocity of 5 feet per second, the discharge of heated air will be $12 \times 5 \times 3600 = 216000$ cubic feet per hour. The resistance to the flow will be diminished nearly in proportion to the square of the velocities, and we shall have $K^2\ V^2 = 9 \times 25 = 225$. The value of r will also be somewhat diminished, and may be taken as 2, so that

$$r\frac{T_s - T_a}{3600} = 0.123.$$

$$\therefore S = \frac{225 \times 4.244 \times 0.238 \times 519.4}{64.4 \times 50 \times 0.123} = 297.$$

square feet.

The heat expended per second will be $297 \times .123 = 36.53$ units per second, 2191.8 per minute, 131508 per hour.

$$T_c = \frac{36.53 + 1.01 \times 519.4}{1.01} = 555.5° = 96° \text{ F.}$$

$$D^c = 0.0808 \times \frac{491.4}{555.5} = 0719.$$

The theoretical velocity in the last case will be

$$V^1 = \sqrt{2g \times 50\left(\frac{555. - 519.4}{519.4}\right)} = 15 \text{ feet per}$$

second; *i. e.*, three times the actual velocity, which was assumed to be 5 feet.

The weight of air discharged will be 216, $000 \times 0.0719 = 15530$ pounds per hour, only slightly in excess of the quantity required, which was 15280 pounds.

It will be seen that the quantity K^2, the coefficient of the square of the velocity, and in regard to which the most uncertainty exists, has an important influence on the quantity S. It seems probable that a value of K between 3 and 4, or of K^2 between 9 and 16, will answer for all ordinary cases, and that a value of r between 2 and 2.5 will be approximately near enough. The smaller values correspond to low velocities and large flues, and the larger values to high velocities and smaller flues.

If the value of V be assumed as 5 feet per second, and that of K as 3, or K^2 as 9, then, by combining the constants in equation (10) we may write approximately.

$$S = 1500.\frac{W\ T_a}{H\,(T_s - T_a)}$$

and for the area of the cross section of the flue or flues for a given discharge (W) we have

$$A = \frac{W}{D_c\ V}$$

n which V, the velocity, is 5 feet per second.

These last equations are suggested as working formulæ under ordinary circumstances. Further experiments are desirable for ascertaining the values of K and r under ordinary conditions of the problem; still the formulæ while only approximately correct, exhibit the laws which control the movements of the air.

To compare this method of ventilation with that by means of a fan or blower, let it be supposed, as found in the last example, that the heating surface required is, in round numbers, 300 square feet. The quantity of heat transferred per second would be 300×0.123 (nearly), or about 36.9 units of heat; per hour, 132840 units. If we estimate in round numbers about 1100 units to raise the temperature of water from 60° and evaporate it at 281°, corresponding to 50 pounds pressure, we shall have

$$\frac{132840}{1100} = 120.7$$

pounds of water necessary to produce this amount of heat. Estimating one horse power per hour at 40 pounds of water evaporated under the same conditions, the heat expended for ventilation would furnish in an engine about three horse power.

Compared with the estimates of the horse power required for a Sturtevant blower to produce the same effect, the steam coils are more economical than the blowers. There seems to be no doubt that steam coils properly devised and adapted to chimneys or flues will give more efficient ventilation than the blower, for less cost of construction and maintenance.

A more extended discussion of this subject might be given, especially with reference to the constants in the equations; but the object of this paper is merely to open the discussion of the subject and to point out the correct method of treating the problem.

The arrangement of the steam pipes in such a manner that the greatest amount of heat will be transferred to the air with the least resistance to its motion, is a matter of importance. It is desirable, if possible, to place these pipes within the flues, and it is a difficult matter to introduce the requisite amount of heating surface, if dependence is placed solely on the direct contact of the air with the steam pipes.

The following plan is suggested for overcoming the difficulty. It has not, as far as I am aware, been heretofore practiced. Vertical pipes, which are to contain live steam, are introduced into the flue, extending five, ten, or twelve feet upward in the flue. These are separated by sheet-iron diaphragms, which receive heat from the steam pipes by direct radiation.

The flue is thus divided into several smaller flues at its base, the whole surface of these smaller flues, as well as the walls of the main flue, acting as heating surface. Air does not receive heat by radiation, but, on the other hand, it does not obstruct the radiation of heat.

The figure above shows how large amount of actual heating surface with a minimum amount of steam pipe may be introduced into the base of a flue. In this case the flue has a cross section of eight square feet, and it contains eighteen vertical steam pipes, each two inches in diameter and twelve feet long, the pipes being closed at the top with suitable air valves.

By means of the diaphragms shown, the actual heating surface with which the air comes in contact, is as follows: for each foot in height (of the 12 feet) of flue occupied by the pipes.

For the steam pipes, $\frac{5}{12} \times 18 = 9$ square feet.

For the walls of the diaphragms, including the flue walls, $2'.66 \times 18'. = 47.88$ square feet.

Total per foot height, 56.88 square feet.
Total for 12 feet high, 682.56 square feet.

Thus, for a total exterior surface of steam pipes of 108 square feet, an actual efficient surface for heating the air is obtained of 682.56 square feet.

This surface may not all be as efficient as the surface of the pipes, but when it is considered that steam pipes can give off heat by radiation without losing very sensibly their efficiency of heating air by contact under the conditions here given, it is evident that the surplus surface obtained by the diaphragms ought to compensate for the diminution of active pipe surface. Experiments alone will determine this question, but there seems to be no scientific reason why the device should not be effective.

In this case it will not be difficult to determine the co-efficient of velocity K by actual calculation from known data.

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Standard Gear Teeth.

The members of the mechanical section of the Franklin Institute we fear have taken upon themselves a task of greater magnitude than they are aware of. We refer to their attempt to establish a system of gear teeth, and to secure its adoption by manufacturers, to the end that the quality of universal interchangeableness may be brought about. It is said they will recommend a form of tooth that will admit of any diameter of wheels of the same pitch gearing together. In this there is nothing new; on the contrary it has been advocated for a good many years, so it may be presumed that a change of some kind is to be recommended.

The difficulties in the way of the establishment of any rigid system are numerous as well as natural. For instance, many manufacturers who have been to considerable pains as well as expense in establishing what they believe to be the right form of tooth,—at least for their purposes—will have to be convinced that the proposed change will give them something materially better—no easy matter—before they can be induced to throw away the fruits of their labor

Again many manufacturers have an extensive list of gear patterns which cost thousands of dollars, and which they can hardly be expected to abandon. On the contrary they may be expected to add to their list other patterns which shall conform in their general features to those they already have, unless extraordinary means are used to convert them.

There is scarcely, except in the instance of small cut gearing, an approach to uniformity of practice, and yet this is by no means owing to the subject not having been agitated, and in some instances quite fully elaborated.

Some manufacturers use, as far as they believe practicable, teeth, the form of which admits of changes in the relative size of pairs, and in some systems of light gearing this is imperative. On the other hand, it is not believed in many instanees to be advisable to do so, and it is quite improbable that any system of universal teeth that may be devised, except the change be so radical as to mean an entire revolution and an addition to existing knowledge of the whole subject, will, for many purposes, equal the best designs of a pair to run together.

In some instances, in practice, the centers of wheels in use can be considered so permanently fixed, that it may be understood that two wheels will continue in their relative and correct positions indefinitely. Under these conditions, there is a well-known form of tooth that is taken to be well adapted. In other instances, it is certain that the centers are constantly liable to derangement, and in this instance it is as well understood that a different form of tooth gives the best results.

Under these circumstances, it is not easy to see why it is not in strict accordance with enlightened practice to use, with discrimination, both forms.

Although there is good authority on each of the more common forms of the teeth of wheels, there are still minor points in their construction that are left to individual judgment, the latitude allowed being well observed. This, however, would, perhaps, be easily enough made uniform.

Taken altogether, the difficulty of convincing interested parties that one form of gear teeth is the best for all circumstances; that it is best to modify that form to suit all conditions, and, in addition, to satisfy them as to what that general form shall be, as well as its precise limits, to say nothing of educating some thousands who are a law unto themselves in these matters, is certainly an undertaking of considerable magnitude. At least the difficulties in the way, as compared to the bringing around the adoption of a standard screw thread—which has progressed just far enough to be troublesome—would seem almost infinite.

It is not well to prejudge efforts in this direction, but it is unobjectionable to foresee difficulties before encountering them, as they are then more easily met.

Simple Method of Instructing Workmen.

In many of the machine shops, particularly railroad shops, scattered all over the country, there are hundreds of workmen who do not understand the simplest forms of mechanical drawing. If a person should go to these workmen and ask them why they did not study mechanical drawing, he would almost always find an eager dispostiion to learn, coupled with a deep regret that no opportunity had ever been offered to acquaint themselves with that very essential part of the business. Many of these individuals are skilled practical workmen, and when they secure a situation in a shop where drawings are used they find it exceedingly difficult to get along. We are acquainted with the foreman of a railroad shop who has pondered a great deal over this problem, and finally has adopted a plan with entire success. He always carried a sketch block in his pocket and never allows himself to give a workman a verbal order unaccompanied by a sketch with the dimensions marked thereon in plain figures.

He then carefully describes to the workman just what is wanted, in as plain language as possible, carefully and pleasantly reprimanding him for asking too many questions which would tend to confuse his mind. These questions, which all workmen who are learning are sure to ask, and which bear upon side issues alone, have to be carefully guarded against at the outset, otherwise the foreman will be likely to lose his patience and give up in disgust all further attempts to instruct the workmen in drawing. They (the workmen) should be kept right to the work in hand. After the sketch is explained by the foreman he then asks the workman to repeat to him just what is wanted, which is sure to show the misunderstanding of a single point, if there is any. The first few attempts were generally unsatisfactory, but it was not long before the workmen began to realize that each line in the sketch represented a certain shape, and these rudimentary instructions from the foreman very soon gave them sufficient knowledge to read plain detail mechanical drawings.

At the present time all work under the direct charge of the foreman alluded to is executed from drawings. In shops where no drawings are used and all work is performed according to verbal orders, there is always more or less confusion. For instance a workman has forgotten a certain dimension, and as the foreman is passing the workman asks him for information. He, without stopping, gives an answer without fully understanding or stopping to consider what is meant by the inquirer. The workman chalks down on some part of his machine or bench the dimensions as he understands it.

Again the foreman comes along to see how matters are progressing and expresses his surprise at finding the part about which the inquiry was made too small, and proceeds at once to deliver a sharp reprimand to the workman for making a mistake.

The workman, if he be at all dignified, at once takes and maintains the ground that he had orders to make it so, and immediately points to the figures in chalk as an evidence that his statement is correct.

The foreman says that if he gave that dimension he did not mean it, or he will advance some like excuse. At all events the final result will be that the foreman will maintain the advantage, and if the workman does not get out of patience and quit, he will lose his respect for the foreman and feel that he has very unjustly been taken advantage of. By using pencil sketches with plain dimensions marked upon them, the workman, after completing his work, can file them away for future reference should future occasion require, when they may be produced as evidence either for or against him.

By adopting the sketch system the foreman, in a seemingly unconscious way, gives the workmen a series of lessons in mechanical drawing which they at once appreciate, besides relieving himself from wasting much time in closely watching each one to see that he does not make mistakes. The time used in making pencil sketches is well employed, and will prove a paying investment.

It is supposed in offering these suggestions that foremen fully understand mechanical drawing, but as there are instances where those individuals do not understand the science, we say to such *lose no time in learning, that you may impart the knowledge to the workmen under your charge.*

False Notions About Skilled Labor.

In the report of an interview with a leading "labor reformer," recently published in the *New York Star*, the following question and answer appears:

"Will you name, briefly, one or two additional forces which underlie the existing discontent among the trades?"

"One is the gradual but certain disappearance of the difference between skilled and unskilled labor, consequent upon the introduction of machinery. Most workmen in many trades, the manufacturing trades, now make only a small part of a given product. For instance, Mr. Charles H. Litchman, formerly Grand Secretary of the Order of St. Crispin, said in a recent speech that a modern shoemaker is only about the fiftieth part of a man, meaning that he makes only that fraction of a shoe. The result is that the shoemaker who can make a whole shoe will soon be as rare a bird as the dodo. This tends to upset the old system, while things have not yet settled down to the new. Furthermore, machinery dispenses with more hands from year to year, and hence parents don't know what trade to teach their children."

Our readers generally will recognize the arrant nonsense in the opinion here quoted, yet there are thousands that read the daily papers who accept such statements as this without inquiring further into the subject. What constitutes skilled labor? Is the ability to successfully feed a machine in a shoe manufacturing establishment properly called skilled labor? If so, the farmer's "hired man" is a skilled workman in a much higher sense, for it takes him many times longer to acquire the requisite knowledge of his business. Strictly considered a certain kind of skill is needed in any occupation even to shoveling gravel, but when "skilled labor" is mentioned in the broad acceptation of the term it means labor directed by *knowledge of a trade*. A machinist is accounted as a possessor of skill, but a man who runs a machine in a machine shop is not necessarily a machinist. He may feed an automatic machine under the eye of a foreman without having learned the trade at all. In fact a large part of the help employed in shops, mills and factories is unskilled labor, yet familiar with the kind of work to be done. The man with whom the *Star* reporter had the interview probably belonged to the latter class. The difference between skilled and unskilled labor is widening every year, "consequent upon the introduction of machinery." The supply of the former is growing relatively smaller and higher priced, and the latter larger and lower priced. This fact constitutes one of the "forces which underlie the existing discontent among the (so-called) trades."

The really skilled workman of the present day has original ideas and is progressive. He aims to improve existing methods of manipulating work, and as a means to accomplish this takes pains to inform himself what others have done and are doing in this branch of industry. He reads, studies, observes and applies the results of his researches. The ordinary machine feeder does nothing of the kind. The latter individual is convinced in his own mind that there is a "gradual disappearance of the difference between skilled and unskilled labor," for he is paid no more than the man who drives a team of mules, or loads trucks with merchandise. He sees that "machinery dispenses with more hands from year to year" required to do a given amount of work, yet has no ambition to inquire who are devising and constructing that machinery, nor to investigate the methods they employ in such operations. He knows next to nothing of the kind of labor that produces the machinery that alarms him about the safety of his "trade," yet is ready with his wail of impending danger when some reporter of a daily paper takes out a note book in his presence.

It is not an easy matter to learn a trade thoroughly, since the division of labor has been so systematized by improved machinery

but the rewards are proportionate to the increased difficulties in the way of acquiring the knowledge which fits an individual for "skilled labor."

We have received two pamphlets, with the "compliments of James B. Eads." One is a collection of letters from leading engineers and naval architects as to the practicability of constructing and operating a ship railway in Mexico across the Isthmus of Tehuantepec; the other is a favorable report of the Congressional Committee on Commerce on a bill which provides that the U. S. Government shall "*guarantee the payment for the period of fifteen years of dividends at 6 per cent. per annum upon the par value of* $50,000,000 *of the capital stock of the company.*"

The project to build the railroad is doubtless a good one, and we should like to see it carried out, but the proposition to require the taxpaying industries of this country to guarantee $3,000,000 a year for fifteen years ($45,000,000 in all) to an enterprise of this kind in a foreign country is about the coolest piece of effrontery ever offered the American people. It far surpasses any scheme for "the old flag and an appropriation" brought forward by Col. Mulberry Sellers, for this is for an appropriation of the first magnitude, with the old flag left out. Any representative of the people found helping such a scheme ought to be consigned forever to oblivion.

We present this week an interesting letter from Geo. B. Foote, of Helena, Montana, giving some facts in regard to mechanical and other business matters in that territory. He points out some instances of gross carelessness, or ignorance on the part of steam boiler owners, and suggests the necessity of a boiler inspection law. It ought to be a comparatively easy task to secure the enactment of such a law in the territory, as there are but few that would oppose it. It would be a credit to Montana when she applies for admission as a State, to be able to refer to the fact that timely provision had been made for the safety of all steam generators within her limits, and that her productive industries were free from those terrible disasters which are so frequently chronicled in the daily papers under the heading: "Another Fearful Boiler Explosion."

QUESTIONS & ANSWERS.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly, and according to common sense methods.

(141) R. S., Paterson, N.J., asks whether the Colt Disc Engine has ever been described by us? *A.* A full illustrated description of the Colt Disc Engine appeared in the AMERICAN MACHINIST, of Oct. 23, 1880.

(142) F. M., East Boston, Mass., asks: 1. Can you tell me how to apply for a patent? *A.* Consult a reliable patent attorney. 2. How long does a patent continue in force? *A.* 17 years. 3 How much will it cost? *A.* Ordinarily the attorney's fees and the Patent Office fees together amount to $65.

(143) J. I. J., Rock Falls, Ill., asks: How shall I make a tool for turning chilled iron? *A.* Special brands of steel are generally used for this purpose. Make a tool with very little rake and harden as hard as possible, using salt and water, or mercury.

(144) J. L. S., Corning, Iowa, writes: I have talked with locomotive engineers and find they claim that the piston in a locomotive cylinder does not travel back and forth as in a stationary engine, but that the cylinder travels over the piston. What ground is there for this argument? *A.* None.

(145) J. S. K., Erie, Pa., asks; How long to make the lever of shears to shear steel ¼" x 3-16? *A.* It will require about 1,500 pounds pressure on the shear blade to shear the steel. If you calculate the lever so that the motion where the power is applied is about 25 times greater than that of the shear blade, it will be about right.

(146) N.D.B., Buffalo, N.Y., asks: Do most manufacturers make employes pay for the damage they may do to machines while using them, the having been duly cautioned. What is the custom? *A.* Some manufacturers exact payment under the circumstances, but comparatively speaking they are few. We believe the custom is to dispense with the services of workmen who will not use due care in the use of costly machinery.

(147) A. J. D., Fort Wayne, Ind., asks; In a link motion engine in which the throw of eccentric is 5", lap of valve ¾", lead 1-16" where will the cut-off occur with the lever in the corner? *A.* If the valve had a travel equal to the throw of the eccentric and was uninfluenced by the link, the cut-off, neglecting the angularity of the connecting rod, would occur at about .89 of the piston stroke. In the case of the link motion there are usually various conditions that influence this, and which render a mathematical solution practically impossible.

(148) H. E. G., Alleghany, Pa., asks: Will you please tell me whether 14" is too early or too late in the stroke to release the steam in a 12" x 16" plain slide valve engine that is to be run at 300 revolutions per minute, the ports being properly proportioned? *A.* We should release the steam at about 15¼". 2. It is said that if a plumb line is let fall from the inside of a high tower, the point of the bob will describe a complete circle in 24 hours. In other words that the line will not hang plumb. Do you know what circle the point of the bob will describe? *A.* Our opinion is the line will hang plumb unless there is some apparent disturbing cause.

BUSINESS SPECIALS.

Transient Advertisements, 50 cts. a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Wednesday morning for the ensuing week's issue.

We receive numerous inquiries relating specially to matters of private interest. While desirous to oblige our friends, we would suggest, that an advertisement of two or three lines under this heading will usually develop the desired information easily and quickly.

Portable Forges, $10. Holt M'fg Co., Cleveland, O.

Presses & Dies. Ferracute Mach. Co., Bridgeton, N.J.

James W. See, Consulting Engineer, Hamilton, O.

Presses and Dies. Ayar Mach. Works, Salem, N. J.

Latest and best books on Steam Engineering. Send stamp for Catalogue. F. Keppy, Bridgeport, Ct.

Foot Power Machinery, for workshop use, sent on trial if desired. W. F. & John Barnes, Rockford, Ill.

J. C. Hoadley, Engineer and Expert, 29 High St., cor. Federal, Boston, Mass.

R. Dudgeon, 24 Columbia st., New York, Improved Hydraulic Jacks and Roller Tube Expanders.

Do you manufacture Hardware or House furnishing goods you wish sold in New York? If so, address Manufacturer's Agent, care of AM. MACHINIST.

For Sale—One Richard's Indicator, nickel-plated and in good order. Address, H. L. Butler, E. High street, Germantown, Philadelphia.

100 New Lathes, Planers Drills, Millers, &c., (light & heavy). Send for list. Kelly & Ludwig, 49 & 51 North Seventh street, Philadelphia, Pa.

Machinists' Bench Tools; largest stock in the United States. Send for Machinist Catalogue, 212 pages. Tallman & McFadden, 607 Market st., Philadelphia.

J. E. Kelley, New Haven, Conn., a roofer of long experience, writes to T. New, 32 John street, N. Y.: Your process for manufacturing Prepared Roofing is perfect, giving entire satisfaction.

"How to Keep Boilers Clean," and other useful information for steam users and engineers. Book sent free by the publisher. Jas. F. Hotchkiss, 84 John Street, New York. Mention this paper.

"Slide Valve Gears," by Hugo Bilgram, published by E. Claxton & Co., Phila., describes the easiest method known for correctly proportioning slide valves, link-motions and cut-off gears; price, $1.00.

Russell & Struthers, Wax Process for making outline engravings. Specimens each week in the AMERICAN MACHINIST. We also do Map Engraving with best facilities. Russell & Struthers, 59 Park Place, New York.

Wanted—Iron Planer about 40 inches square by 12 feet long, new or second hand at once. Send cuts and cash price to Bentel, Margedant & Co., Hamilton, Ohio.

"Steam Economy," by Alfred Wilkinson, M. E., 123 N. 4th St., Philadelphia. Tells how to use the indicator. Points out and remedies defects in Steam Engines. Illustrated with numerous diagrams. Great variety of practical information for steam users. 124 pp., paper, 75c., cloth, $1.00 by mail.

"Sibley College of Mechanic Arts, Cornell University.—Entrance examinations will be held June 12th and September 11th, 1882. For the register and catalogue just issued, containing reorganized courses of instruction, scientific and practical, including draughting, machine construction, general shop work, etc., apply to the President of Cornell University, Ithaca, N. Y."

Bound Volumes and Patent Binders. We can furnish Volume 3 of the AMERICAN MACHINIST, containing the full 52 issues of 1880, or Volume 4, containing the 53 issues of 1881, neatly bound in cloth, ready to ship by express, for four dollars. Either volume unbound, three dollars. "Patent Binder" for the AMERICAN MACHINIST holds 53 weekly issues in good shape. Sent to any address by mail for one dollar. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton Street, New York.

Ealy's "Blue Book,"—Special classified list of Machinists, Machinery, Railway, Engine and Boiler Makers supplies, etc., with financial standing and paying qualities of all dealers and manufacturers. Much more convenient and reliable than any other work of the kind published. We also furnish full detailed written reports. Price $30 to July 1, 1882. The JOHN W. EALY COMPANY, 51 Chambers street, New York or 79 Dearborn street, Chicago, Ill.

"Extracts from Chordal's Letters," the most interesting mechanical book published. A great variety of mechanical and business topics treated in a wise and witty way that will be instructive to old and young mechanics, and interesting to everybody. As many as 150 copies have been sold in a single shop. Over 40 Humorous illustrations; 320 pages, 12 mo. Price, $1.50 per copy, by mail, to any address. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton St., New York.

MANUFACTURES.

Critchley & Whalley, Portsmouth, N. H., have erected a foundry 65x30 feet.

The Exeter Machine Works, Exeter, N. H., are building an addition to their foundry.

Benjamin Eastwood, Paterson, N. J., will erect a 50x40 foot addition to his machine shop.

Walker & Atwood, Brockton, Mass., will soon erect an iron foundry.

Aultman, Miller & Co., Akron, Ohio, will make a large addition to their foundry.

Albro, Chase & Reed, Fall River, Mass., have just built a new machine shop 60x40 feet.

David W. Pond, Worcester, Mass., is about to bring out a new 60-inch square planer.

The Victor Mowing Company, of Niverville, N.Y., has been reorganized with a capital stock of $40,000.

Union Iron Works, Trenton, N. J., builders of steam engines and machinery, are about to enlarge their foundry

The Singer Sewing Machine Company of Elizabeth, N. J., is considering the advisability of removing its works to Johnstown, N. Y.

The new joint stock company to be organized in New Britain, Conn., for the manufacture of malleable iron, will be called the Judd Iron Company.

Munn & Baush, Holyoke, Mass., will erect an addition 30x100 feet to their foundry and increase their force of workmen.

The Union Foundry Works, of Chicago, have recently increased their capital from $100,000 to $250,000.

The Mississippi Mills Company, at Wesson, Miss., will soon build another large cotton mill, to cost not less than $300,000.

The Machine Works of E. P. Allis & Co., Milwaukee, Wis., employ 1,000 men and are running night and day.

An extensive shop will be erected this spring by Howard Brothers, of Fredonia, N. Y. It will be used for the manufacture of a new nut-tapping machine.

The Alice Blast Furnace, of Birmingham, Ala., cleared $12,000 during the month of January. The investment cost $250,000, yielding a net income to its proprietors of $144,000 per annum.

The Peck, Stow & Wilcox Co., at Kensington, Conn., intend to put up a new factory for their Chisel works, and will put in a steam engine when the dry spell comes.

The Kruse Manufacturing Company have opened a shop at 124 East 14th street, New York, for the manufacture of all kinds of light automatic labor-saving machinery in any quantity desired.

The Florida Southern Railway contemplates putting up new mills along its line of road at once. Two are now in course of erection, one at McMeekin and the other at Magnesia, Fla.

Russell & Co., Massillon, O., have issued their fortieth annual catalogue for 1882, containing illustrations and descriptions of their steam engines, agricultural and saw mill machinery.

The Queen City Machine Works, Reinshagen & Buckman, Cincinnati, Ohio, have been started for the building of machinists tools and specialties in iron and brass.

The Chicago Lumber Co. are pushing rapidly forward their new mill in Chicago. Most of the heavy machinery has arrived, and the 500 horse-power Atlas Corliss engine is now being set in position.

Messrs. Chas. E. Hall & Co., are erecting a new Hominy mill at Indianapolis, which will add very materially to the rapidly increasing mill interests of that city. The Atlas Engine Works will furnish the motive power.

The Wiley & Russell Manufacturing Co., Greenfield, Mass., write us that they have a center-reamer ready for market, exactly like that described (with a cut) by George B. Foote in the AMERICAN MACHINIST of March 18th.

Danville, Va., has sold water power on Dan river amounting to $46,217. A water front of 3,000 feet brought $10,000. The purchasers propose to open cotton factories, mills for grain, and machine shops for work on iron and wood.

Ripley Ropes, Commissioner of the Department of City Works of Brooklyn, N. Y., has advertised for bids for a 15,000,000 gallon pumping engine to give a duty of 65,000,000 foot pounds. The bidder may also present plans for two engines of the same collective capacity. All bids must be in by May 10th.

Coleman & Comings have taken the shop formerly owned by Daniel Mulock, in Middletown, Conn. and will manufacture engines, boilers and general machinery, also deal in second-hand machinery. One partner is a machinist and the other a millwright. A foundry will soon be started in connection with the shop.

The Future City Manufacturing Company's new building is completed and machinery is being placed in position to begin the manufacture, on a large scale, of all kinds of wood working machinery. The business is being conducted by three young and energetic young men from the East.—*St. Louis Age of Steel.*

Ten thousand dollars have been subscribed at Titusville, Pa., toward a brass foundry to be located at that place.

The Chattanooga Tradesman relates that Thomas Camp, who has a foundry and machine shop at Covington, Ga., and turns out saw mills, engines etc., says he shall clear $50,000 this year. "My sales of saw mills alone," he is reported as saying, "will cover from $1,800 to $2,000 a week, or about $100,000 a year." The south seems to be a good section in which to locate certain branches of the machinery business.

Stephen Holman, Treasurer of the Holyoke Machine Company, at Holyoke, is soon to erect at Worcester, one of the largest manufacturing buildings in Worcester County. It will require 1,000,000 brick and 330,000 feet of lumber in building. W. C. McClellan of this city has the contract for the brick work. Mr. Holman manufactures water wheels, steam pumps, paper machinery, etc., and moves a part of his business to Worcester.—*Springfield, (Mass.,) Republican.*

The Globe Concentrator Co., No. 15 Oliver street, Boston Mass., Horace P. Tobey, President, has been recently organized and has started a shop for the manufacture of a machine for concentrating and amalgamating the ores of the different metals. The machine combines a mechanical motion with the use of water jets to separate the free metals from the gangue. They have lately shipped to California two machines, and are now building six more, four of which are already sold.

East Saginaw, Mich., is on a boom. Last year one million dollars was put into buildings, and it is estimated as much more will be spent this season. They have, this year, started a large saw and file works, also an axe and tool factory with capital, $50,000. A shop for manufacturing furniture is nearly completed. A. F. Bartlet & Co., machinists, have been obliged to enlarge their shops, and have built new shops of brick. In the Saginaw Valley, last year, was produced 2,745,000 barrels of salt.

The Wamsutta Mills, New Bedford, Mass., are setting five Corliss boilers with the Jarvis furnace. Among other boilers being set with this furnace are, one for Wheelwright Paper Co., Fitchburg Mass., one for John J. McNutt, Boston, and one for Miller Bros. & Co., Somerville, Mass. The Pond Engineering Co., of St. Louis, have orders to set four boilers at Park Mills, in that city with Jarvis furnace, four at Bathalto, Ills., one for James Beach, Dubuque, Iowa, one for the Cincinnati Type Foundry, two for Gerke Brewery, Cincinnati—a second order, four for Gaff, Fleischmann & Co., Sedamville, Ohio, and two for a company in Louisville, Ky. There are nearly 1,600 boilers set with the Jarvis furnace.

The *Industrial World* publishes notes of ten or a dozen enlargements and additions in the way of machinery to Racine, Ills., manufacturing establishments. Among these extensions are those of S. Freeman & Sons, a brick, three-story machine shop 50x80 feet; Racine Hardware Co., a three-story brick factory 50x125 feet, in which to build boats; Dickey & Pease, a 30x40 foot foundry addition with a new cupola; Jens Jenson, a new blacksmith shop; Breasly & Adams, a 70x73 foot foundry addition; The Racine Wagon and Carriage Co., a brick three-story building, 80x125 feet; The J. I. Case Threshing Machine Co., a new machine shop 600x300 feet and five stories high, for portable saw mill machinery; The J. I. Case Plow Co. A. C. Fish and The Winship Manufacturing Co., considerable new machinery. The town is also to have a new malleable iron works, a new varnish factory and a new mowing and reaping machine factory.

S. W. Goodyear, Waterbury, Conn., writes us: "In your notice of the use of cold swaging machines by The Excelsior Needle Co., of Torrington, Conn., in your issue of April 15th, you speak of them as the Maltby, Hopson & Brooks Machine, which leads me to explain. The machines are known as the Hopson & Brooks Wire-pointing or Reducing Machine. The Excelsior Needle Co. use these machines exclusively for reducing the blades of sewing machine needles, in place of milling, turning, rolling, etc., as practiced by other needle manufacturers. Their needles take a high position in the market, owing to a superior degree of concentricity, uniformity of size throughout the entire length of blade, almost exact uniformity of size of all needles intended for the same number or size, uniformity in depth of grooves, fineness of finish, with freedom from scratches. All of these important features depend, in a great measure, upon the condition of the needle blank as produced by the cold swaging process. Without concentricity no needle can be really first-class. The machine accomplishes this, while to make work round, smooth and uniform in size, is peculiar to this process. It follows that with blades of uniform size the grooves will be alike in depth, while with the smooth planished and burnished surface left by the swaging dies, there is no occasion to grind a blank to that extent which will endanger the uniformity of size, as where transverse marks made by milling or turning must be removed. Another valuable feature is believed to be, that owing to the uniform degree of compression which the needle blade gets in the process of swaging, it will pass through the hardening process with less liability to spring, and further that from a change in the molecular condition of the steel growing out of this peculiar process of cold working, the blade of the needle is actually much stronger than those made by turning, milling or rolling. The production of the Excelsior Co., who are using several machines, is about sixty-thousand blanks daily. There are no doubt many other uses to which the cold swaging process might be applied with as great advantage as in this case. Since my advertisement first appeared in the AMERICAN MACHINIST I have delivered five of these machines. A sixth machine is sold and completed, and now waiting shipping instructions, while a seventh machine of extra large size is in process of construction to be shipped to a wire manufacturing company, May 1st. Said a prominent wire manufacturer when asked what he considered was saved by the use of this machine, as compared with pointing wire for drawing by hand, "I think fully ninety per cent. is saved."

Machinists' Supplies and Iron.

NEW YORK, April 13, 1882.

There is nothing new to report in the general supply business. Trade is generally good with but little accumulation of stock. On the whole orders are accepted for quicker delivery than was the case a few weeks ago, but prices remain substantially unchanged. But few novelties appear, dealers as yet being satisfied with handling standard goods.

The Pig Iron market is dull with but little prospect of mending. Prices are substantially the same as quoted last week although hard to hold. Sales are only in small lots. In scrap iron, yard parcels are quoted at $31.50 to $32. Foreign iron unchanged In general hardware the market shows considerable activity, owing mostly to old orders. Copper is dull; prices nominally unchanged but tending in favor of buyers. Other metals unchanged.

WANTED

"Situation and Help" Advertisements, 30 cents a line, each insertion. About seven words make a line. Copy should be sent to reach us not later than Thursday morning for the ensuing week's issue.

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Wanted—Mechanical Draughtsman. One who is thoroughly posted on engine and pattern work. Address, giving references, etc. SMITH, MYERS & SCHNIER, 323 to 329 W. Front St., Cincinnati, Ohio.

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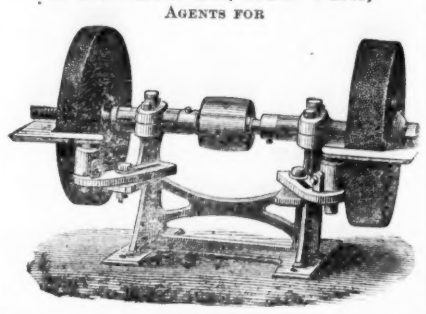

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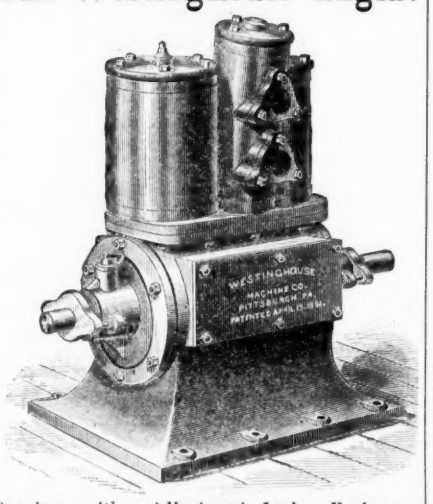

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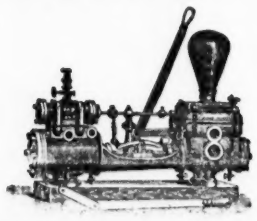

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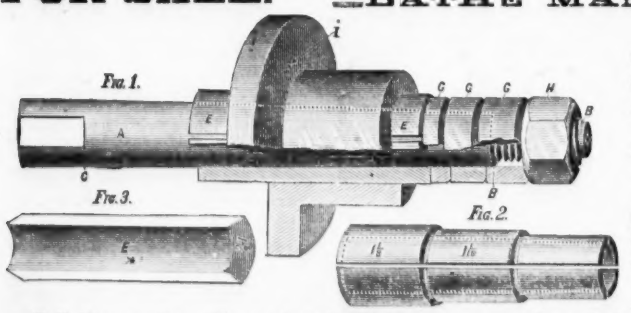

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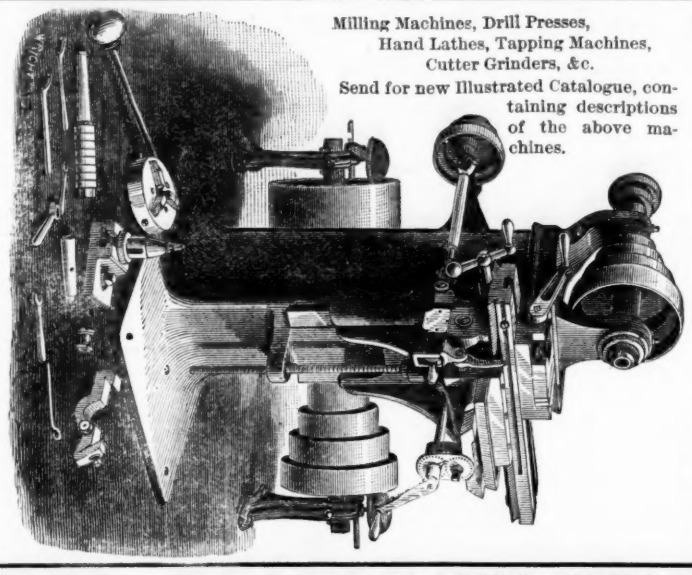

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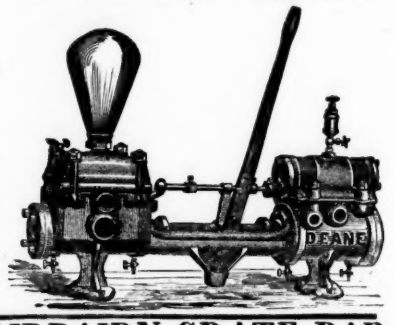

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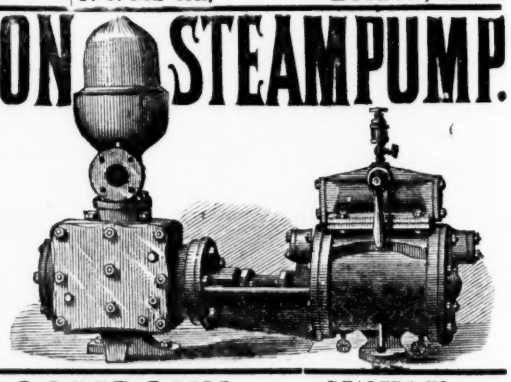

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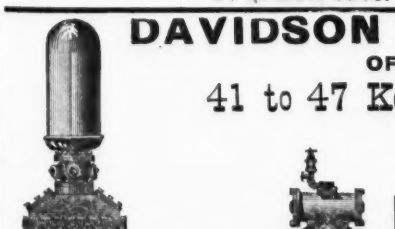

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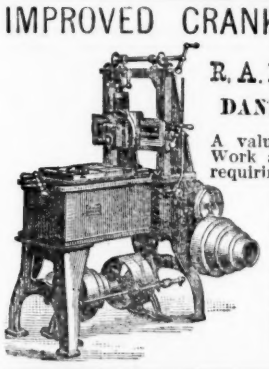

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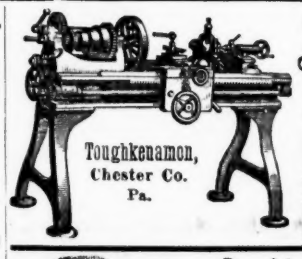

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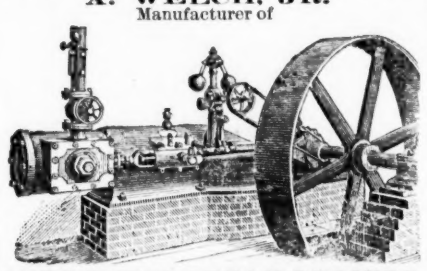

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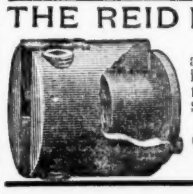

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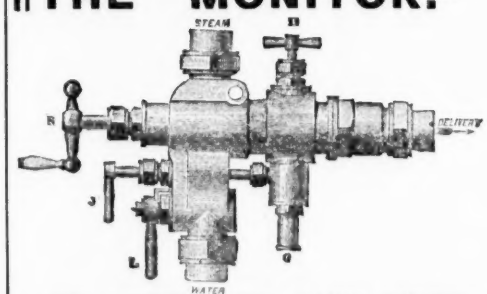

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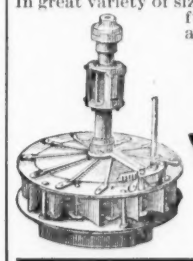

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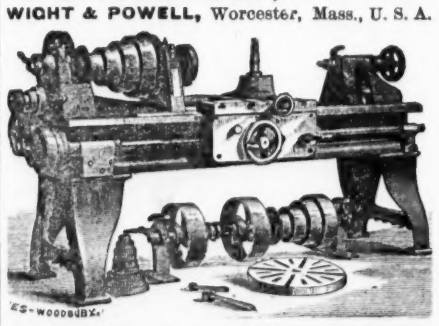

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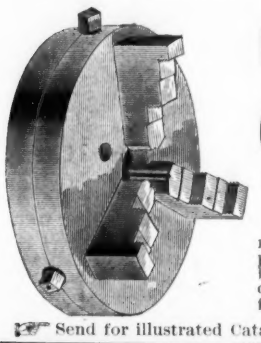

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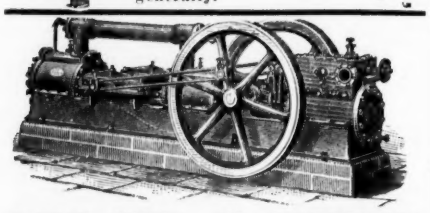

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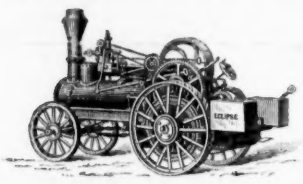

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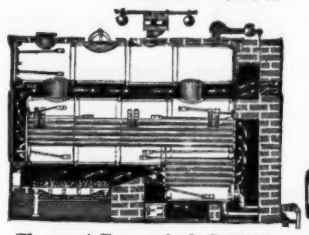

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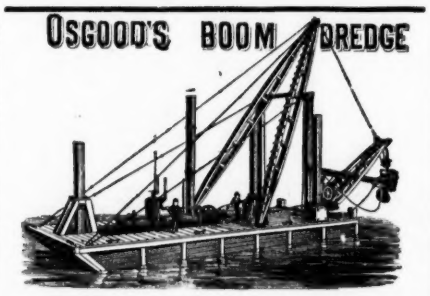

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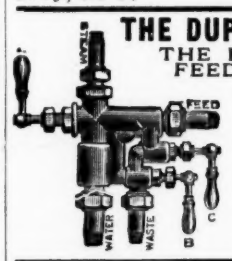

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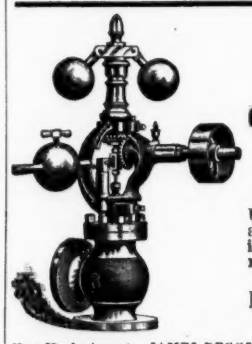

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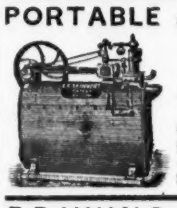

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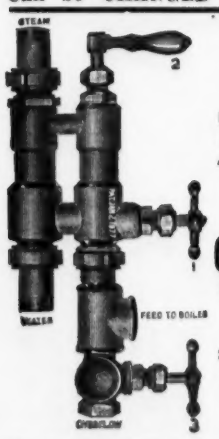

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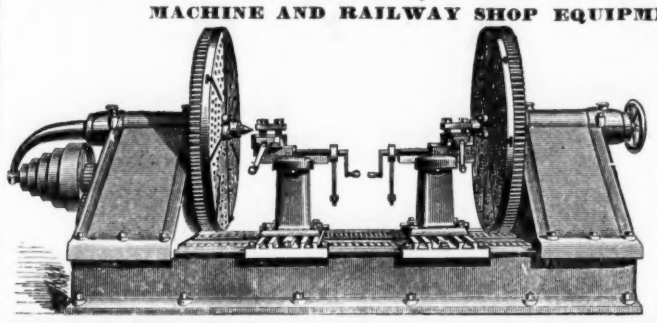

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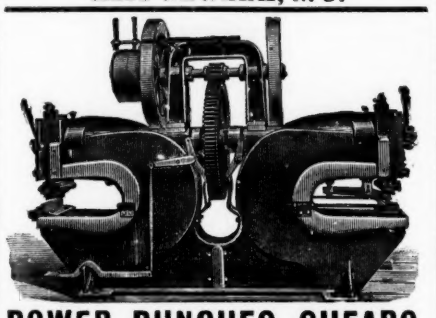

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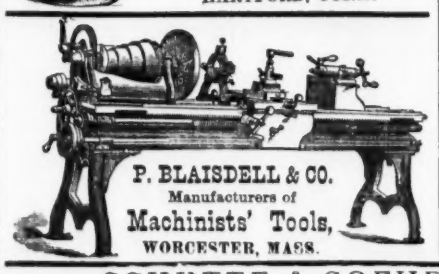

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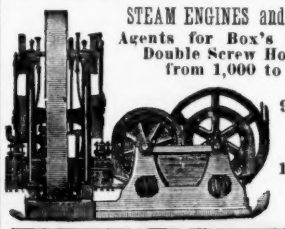

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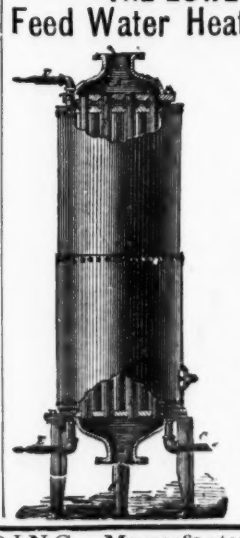

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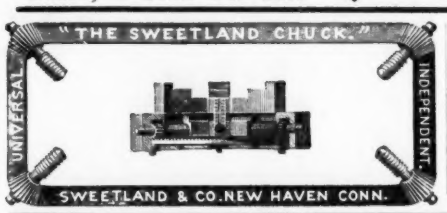

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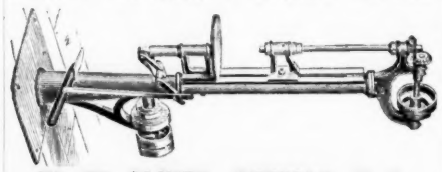

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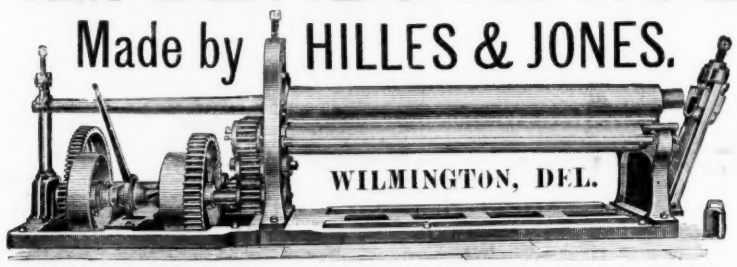

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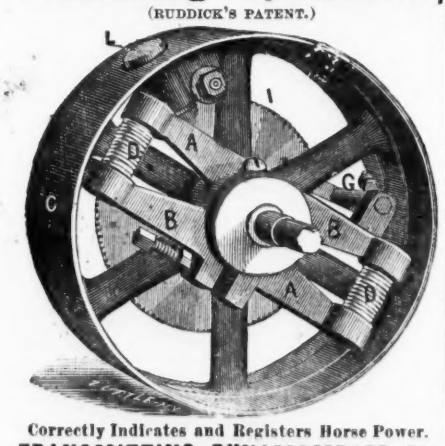

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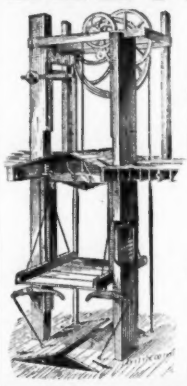

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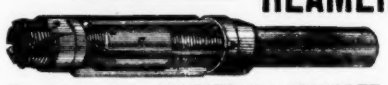

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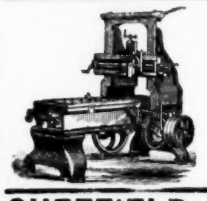

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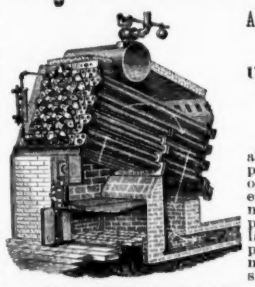

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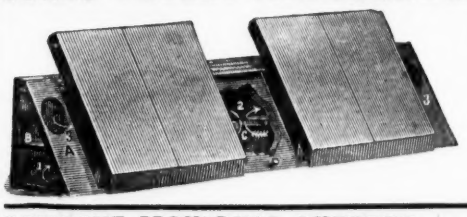

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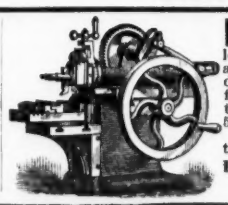

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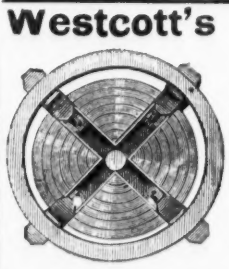

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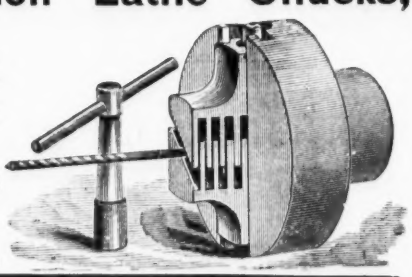

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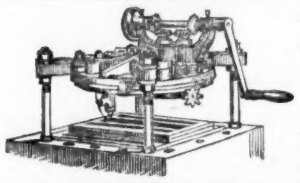

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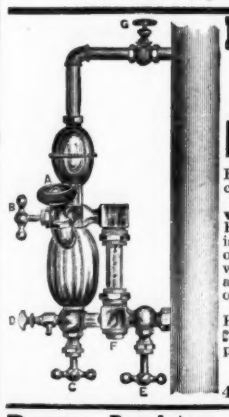

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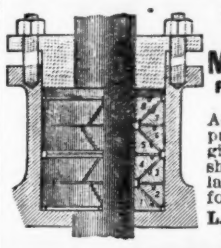

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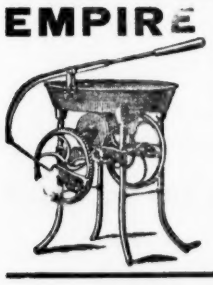

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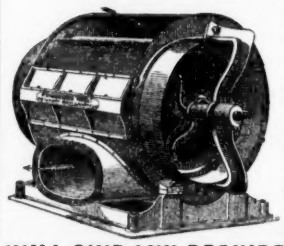

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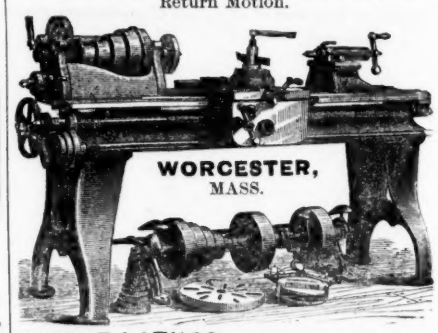

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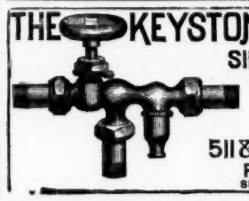

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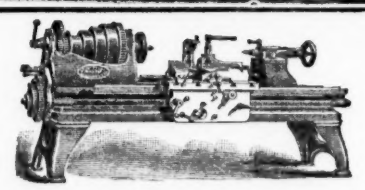

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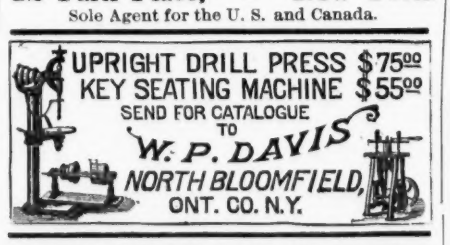

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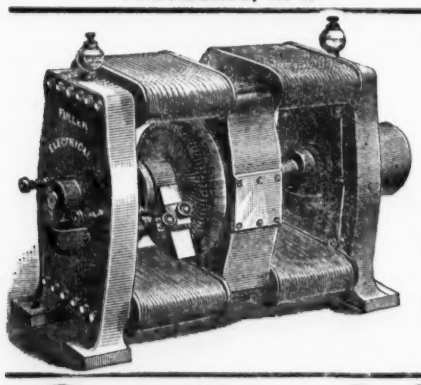

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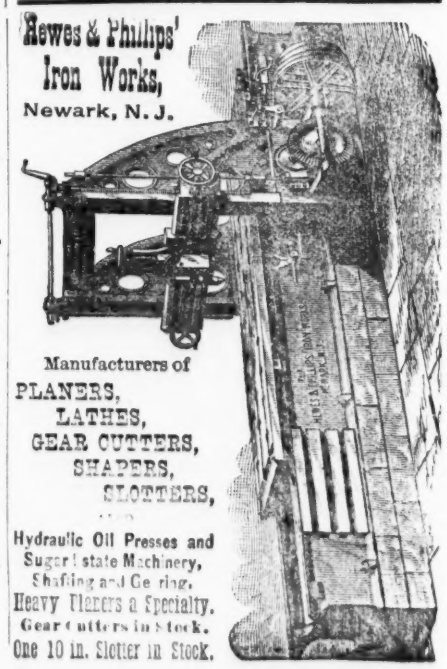

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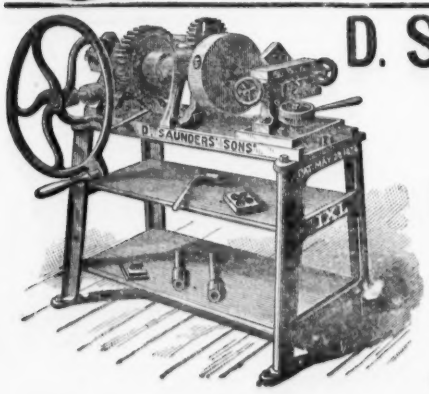

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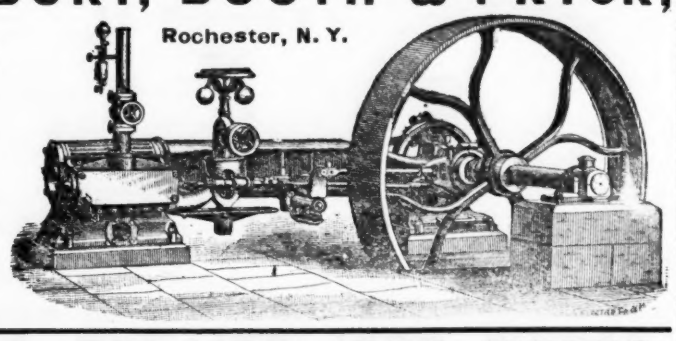

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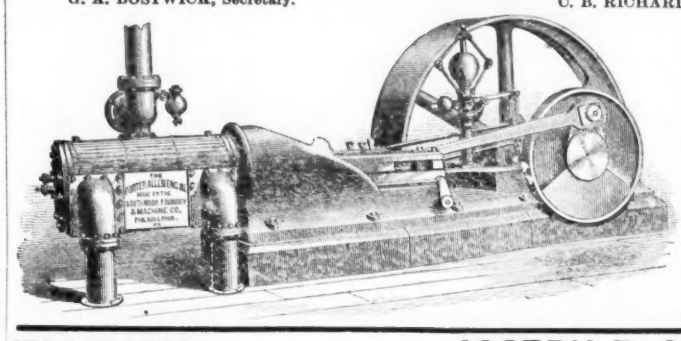

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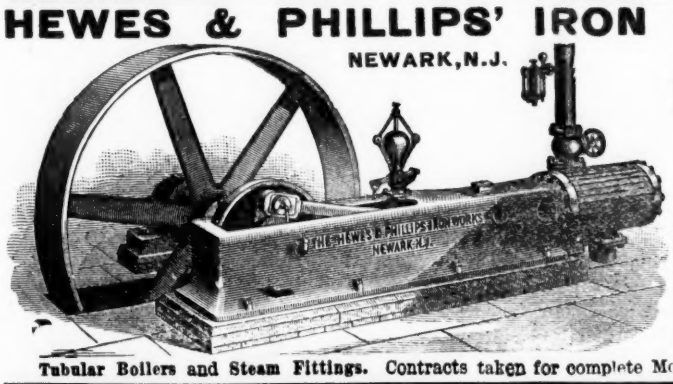

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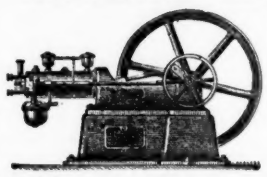

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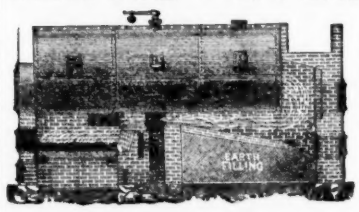

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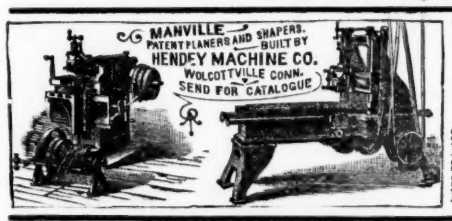

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1 Hand " 12 in. x 5 ft. Garvin. "
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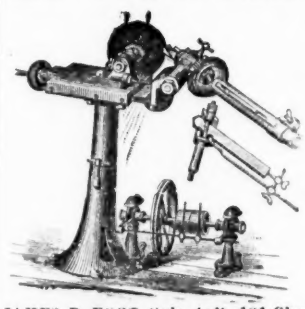

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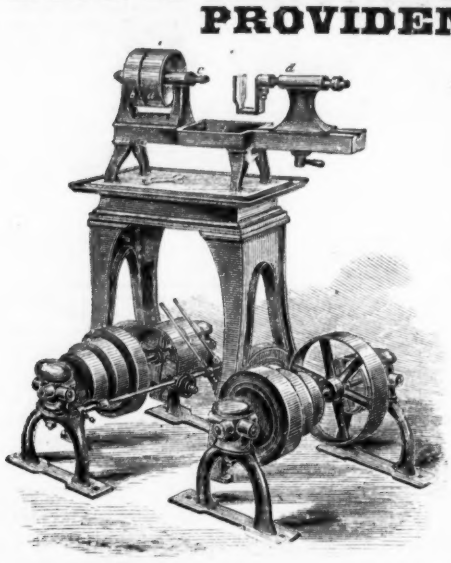

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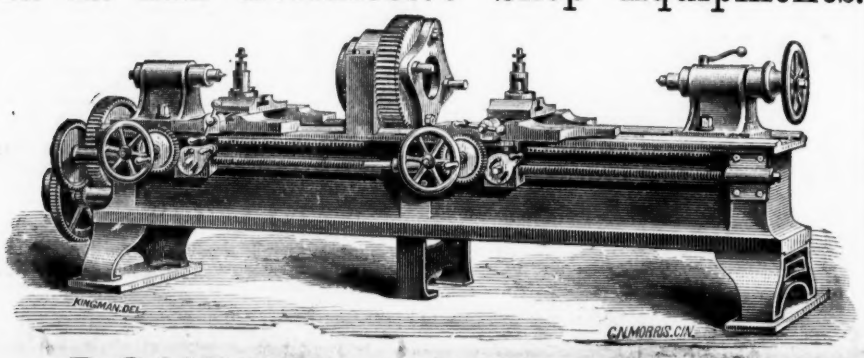

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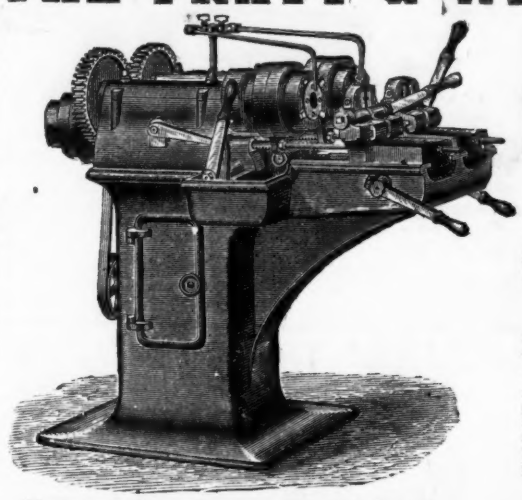

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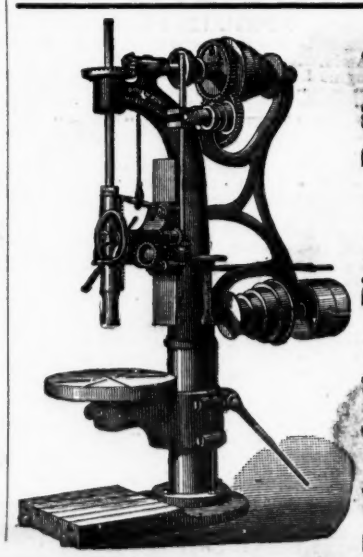

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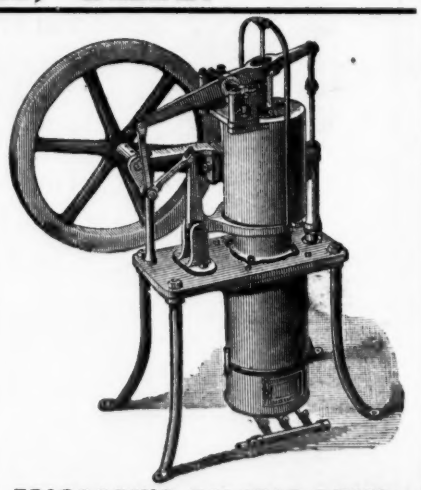

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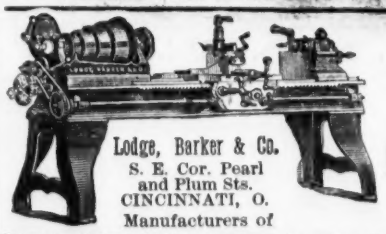

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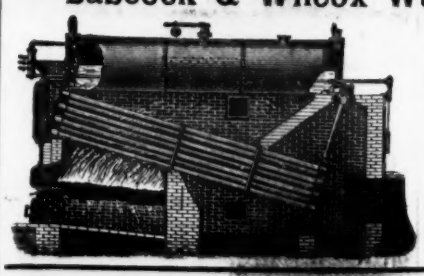

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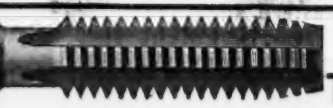

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